Vermont Agency of Natural Resources

Watershed Management Division

Black and Ottauquechee Rivers
and adjacent
Connecticut River & tributaries
Spencer, Blood, Mill, Mill and Lulls Brooks

DRAFT 2017 TACTICAL BASIN PLAN

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION

Vermont Surface Water Management Strategy

Approved:

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Emily Boedecker, Commissioner Date:
Department of Environmental Conservation

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Julie Moore, Secretary Date:
Agency of Natural Resources

Cover Photo: Comtu Falls, Black River, Springfield
By Marie Levesque Caduto

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All Towns Within Basin 10

Andover
Baltimore
Barnard
Bridgewater
Cavendish
Chester
Hartford
Hartland
Killington
Ludlow
Mendon*
Mt. Holly
Plymouth
Pomfret
Reading
Shrewsbury
Springfield
Stockbridge*
Weathersfield
West Windsor
Windsor
Woodstock

Black River

Andover*
Baltimore
Cavendish
Chester
Ludlow
Mount Holly
Plymouth
Reading
Shrewsbury
Springfield
Weathersfield
West Windsor

Ottauquechee River

Barnard
Bridgewater
Hartford
Hartland
Killington
Mendon*
Plymouth
Pomfret
Reading
Shrewsbury
Stockbridge*
Woodstock

Connecticut River & Tributary Brooks

Hartford
Hartland
Reading
Springfield
Weathersfield
West Windsor
Windsor

* Towns with < 3 sq. mi. in Basin 10

Basin 10


BARNARD
POMFRET
KILLINGTON
HARTFORD
BRIDGEWATER
WOODSTOCK
MENDON
HARTLAND
Connecticut River
PLYMOUTH
READING
SHREWSBURY
WINDSOR
WEST WINDSOR
NH
MOUNT HOLLY
CAVENDISH
LUDLOW
WEATHERSFIELD
BALTIMORE
SPRINGFIELD
ANDOVER
CHESTER
ROCKINGHAM
0
2.5
5
10 Miles

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Executive Summary

The Black and Ottauquechee River Tactical Basin Plan (referred herein to as the Basin 10 Plan) provides an overall view of the health of the regions waters and defines on-going and future actions to address high-priority stressors. This Plan includes targeted actions to achieve the State's water quality goals laid out in the Vermont Clean Water Act, the Vermont Surface Water Management Strategy and the Long Island Sound Total Maximum Daily Load. The actions are described in the Summary Implementation Table in Chapter 5 and in the online Watershed Projects Database.

The two major watersheds in the Basin - the Ottauquechee River watershed and the Black River watershed cover 425 square miles of southeastern Vermont from Killington Peak down to Springfield. The mainstem of the Connecticut River from Hartford to Bellows Falls, along with the tributaries within this region are also included in the plan.

In looking at the broader water quality concerns in the Basin excessive sediment, high water temperatures, excessive levels of nutrients and *E. coli* bacteria, physical alterations of stream channels, water level and flow alterations, and habitat alterations are the most pervasive. Impairments of water quality impact 11 miles of rivers and streams with many more being **Altered**[1] or **Stressed** by one or more these factors. The impaired waters are being addressed through the implementation of Total Maximum Daily Load plans and watershed restoration projects identified through this and other regional and local planning processes.

The protection or improvement of water quality and water-related uses is being promoted by establishing specific management goals for individual bodies or stretches of water. The management goals describe the values and uses of the surface water that are to be protected or achieved through appropriate management. Select waters including rivers, streams, lakes and wetlands are proposed for reclassification to increase protection from future degradation.

Since the previous Basin Plan was completed in 2012 over $1,000,000 have been invested by the Vermont Department of Environmental Conservation to improve water quality and habitat conditions in this Basin. Geomorphic assessments have been completed on the Black and Ottauquechee Rivers and several of their tributaires and on Mill Brook in Windsor. These have provided a multitude of potential remediation projects that will

[1] Words in **BOLD** are defined in the Glossary

be reviewed by Vermont Department of Environmental Conservation (VDEC) and our partners to prioritize the most important ones to pursue over the next few years.

The overarching strategies indentified are laid out in the Summary of Implementation Projects Table 17 in Chapter 5. These are intended to address issues and corresponding actions such as:

- Agriculture: Implement Best Management Practices
- Flow Alteration: Restore natural flows
- Forest Management: Abate soil erosion
- Hazard Mitigation & Flood Resiliency: Decrease threats to human safety and property damage
- Impaired & Stressed Waters: Improve water quality and habitat restoration
- River Corridor: Reach stream equilibrium and flood resilience
- Shorelands: Protect and restore
- Stormwater: Reduce pollutants and volume
- Surface Water Protection: Restore and reclassify
- Wetlands: Protect and restore

With the help of our major planning partners in the Tactical Basin Planning process, including the Southern Windsor County Regional Planning Commission, the Two-Rivers Ottauquechee Regional Commission and the Ottauquechee Natural Resources Conservation District and numerous committed partner organizations, municipalities and individual landowners, we will continue working together to implement Plan priorities for the restoration, remediation and protection of water quality and habitat conditions throughout the Basin.

Top Objectives and Strategies

Protect river corridors to allow rivers to reach equilibrium and increase flood resilience through protection of river corridors with conservation easements; active and passive stream channel, floodplain and wetland restoration; resizing of bridges and culverts; and municipal adoption of appropriate ordinances, focusing on the upper Black River and its North Branch, mid-Ottauquechee River and Mill Brook.

Protect riparian areas from encroachment and degradation through buffer plantings, invasive plant control, conservation easements, and municipal adoption of appropriate ordinances for streambank buffers and setbacks.

Mitigate sources of stormwater runoff causing water quality impairments through the development and implementation of stormwater master plans, focusing on Roaring and East Roaring Brooks, Okemo and Trailside Brooks, and the lower Black River.

Implement agricultural Best Management Practices (BMPs) in areas that are a significant source of nutrients and where BMPs are best suited to conditions with a focus on the watersheds of Kedron Brook, lower Ottauquechee River, lower Black River, North Branch Black River, Twentymile Stream and the Connecticut River.

Protect very high-quality surface waters throughout the Basin through re-classification and designation of significant natural resource assets such as biological integrity, recreation, water quality protection, and fisheries, with a focus on locations listed in Tables 12 - 15.

Prioritize and implement wetland and floodplain restoration projects on agricultural lands for nutrient retention and sediment attenuation with a focus on the watersheds of the North Branch Black River, Twentymile Stream and Mill Brook.

Inventory and prioritize municipal road erosion that affects surface water and implement high priority projects that are identified in municipal road erosion inventories.

Promote and implement shoreland protection and restoration through direct outreach with landowners to encourage participation in the Lake Wise Program, which promotes implementation of lakeshore BMPs.

Mitigate flow alterations by working with dam operators to lessen flow variations and work toward run-of-river management.

Summary of Protection Opportunities

Waters recommended for further assessment for reclassification from Class B to Class A(1) for Aquatic Biota & Habitat:

Surface Water:	Town(s):
• North Branch Ottauquechee River	Bridgewater, Killington - All
• Great Brook	Cavendish - Above Cavendish town line
• Black River Trib #9	Springfield - Above Rt. 11
• Tiny Pond Stream	Ludlow, Mount Holly
• Kilburn Brook Trib #1	Hartford
• Barnard Brook Trib 6	Pomfret

Waters recommended for reclassification from Class A(2) to Class A(1) or B(1):

These waters are no longer used or reserved for use as A2 - public water supply

Surface Water:	Town:
• Spring and unnamed trib to the Ottauquechee River	North Hartland
• Carlton Hill Reservoirs	Woodstock
• Wright, Upper and Lower Hurricane Reservoirs	Hartford
• Springfield Reservoir and tributaries	Weathersfield
• Unnamed tributary to Mill Brook	Ascutney

Waters recommended for further assessment to verify conditions for reclassification from Class B(2) to Class B(1) for Aquatic Biota & Habitat:

Surface Water:	Town(s):
• Ottauquechee River	Bridgewater - above Bridgewater Hill Rd
• Lulls Brook	Hartland, West Windsor - above fire station
• Great Roaring Brook	Plymouth

Waters recommended for further assessment to verify conditions for reclassification from Class B(2) to Class B(1) for Fishery:

Surface Water:	Town:
• Jewell Brook	Ludlow

• Grant Brook	Ludlow
• Sanders Brook	Ludlow
• Twenty Mile Stream	Cavendish
• North Branch Black	Cavendish – Upstream of Ascutney Basin Road
• Kent Brook	Killington - Above Kent Pond
• Falls Brook	Killington
• Ottauquechee River	Above Roaring Brook confluence
• Roaring Brook	Killington
• Reservoir Brook	West Bridgewater
• Madden Brook	West Bridgewater
• Dailey Hollow Brook	Bridgewater Center
• Pinney Hollow Brook	Plymouth
• Curtis Hollow Brook	Bridgewater
• Beaver Brook	West Woodstock
• Kedron Brook	South Woodstock
• Barnard Brook	South Pomfret
• Cloudland Brook	South Pomfret
• Babcock Brook	Taftsville
• Whitman Brook	Hartford
• Fulling/Harlow Brook	North Hartland

Waters recommended for Outstanding Resource Waters designation:

Surface Water:	**Town:**
• North Branch Ottauquechee River	Bridgewater, Killington - All
• Buttermilk Falls, Branch Brook	Ludlow
• Cavendish Gorge, Black River	Cavendish
• Comtu Falls, Black River	Springfield

Wetlands to be assessed for potential reclassification to Class 1 or 2

Surface Water:	**Town:**
• Black Pond	Plymouth
• Beaver Pond	Weathersfield
• Killington Flats	Killington
• Lake Ninevah (contiguous)	Mount Holly
• Eshqua Bog	Hartland

Chapter 1 – Tactical Basin Planning Process & Watershed Description

Tactical Basin Planning Process

The Vermont Department of Environmental Conservation's (VDEC) tactical planning process is designed to identify and prioritize state and local water quality issues and lead to implementation of on-the-ground watershed protection and restoration projects. Plans are designed to meet the goals and objectives of the Vermont Surface Water Management Strategy (VSWMS) to protect, maintain and restore the biological, chemical, and physical integrity, and public use and enjoyment of Vermont's water resources, and to protect public health and safety. The VDEC collaborates with state, federal, regional and municipal organizations, local conservation groups, businesses, and a variety of landowners and interested citizens to develop the water quality management plan for waters in these Basins.

Plan Implementation

This Tactical Basin Plan (TBP) includes targeted actions to achieve the State's water quality goals laid out in the Vermont Clean Water Act, the Vermont Surface Water Management Strategy and the Long Island Sound Total Maximum Daily Load. The actions are described in the Summary Implementation Table 17 in Chapter 5 and in the online Watershed Projects Database which is continuously updated as projects are implemented, as new projects come to light from newly emerging information and unanticipated events, as priorities change and as new requirements arise. Actions are reviewed and prioritized for implementation by regional Clean Water Advisory Committees which consist of municipal and non-profit representation. Successes and challenges in implementing actions will be reviewed in biannual meetings with watershed partners.

In order to implement high priority actions, watershed partners apply for funding, coordinate projects and track the progress of measurable indicators of outcomes. The Clean Water Fund has been established, and paired with other funds available for water quality improvements. Funds are dedicated towards the highest priority water quality remediation actions.

For more information about the Vermont Clean Water Act, readers should review the content of the Vermont Clean Water Initiative website at: http://dec.vermont.gov/watershed/cwi.

The life of this Plan is envisioned to be five years. It is expected that the Agency and its partners will develop adaptive management techniques as new natural events such as major storms, and human-caused changes, alter conditions over time.

Many partners are integral to the planning process, these include:

- Black River Action Team
- Connecticut River Joint Commissions and
    - Mount Ascutney Local River Subcommittee
- Connecticut River Conservancy
- Great River Hydro formerly TransCanada Hydro Northeast Inc.
- Lake Ninevah Community & Foundation
- Lake Rescue Association
- Municipalities throughout the Basin
- Ottauquechee Natural Resources Conservation District
- Ottauquechee River Group
- Southern Windsor County Regional Planning Commission & Clean Water Advisory Committee
- Trout Unlimited, Greater Upper Valley Chapter
- Two Rivers-Ottauquechee Regional Commission & Clean Water Advisory Committee
- US Army Corps of Engineers
- USDA
    - Forest Service and
    - Natural Resources Conservation Service
- VT Agency of Agriculture, Food and Markets
    - Water Quality Division
- VT Agency of Natural Resources Departments of
    - Environmental Conservation
    - Fish and Wildlife
    - Forests, Parks and Recreation
- VT Agency of Transportation

Vermont Water Quality Standards and Clean Water Act

The Vermont Water Quality Standards (VWQS) are rules specific to Vermont that protect the waters of the state. These rules expand upon the 1972 Federal Clean Water Act, which requires states "to restore and maintain the chemical, physical and biological integrity of the nation's waters." The VWQS define **biological integrity** as the ability of an aquatic ecosystem to support and maintain a community of organisms that is balanced, fully functional (integrated), resilient to change or impact (adaptive), and has the expected species composition, diversity, and functional organization for its type of ecosystem. The health of a biological community reflects the level of combined human-induced stresses acting upon it. Aquatic communities that are most impaired suffer from an accumulation of multiple stressors.

The implementation actions identified in this Tactical Basin Plan are meant to fulfill all the geographically-specific planning requirements in the VWQS, while the statewide planning requirements, including state-scale strategies, are addressed in the statewide Surface Water Management Strategy.

In 2015 the Vermont Legislature passed Act 64, the Vermont Clean Water Act, which creates new statutory authorities and strengthens multiple statutes related to water quality in the State. The Act addresses agricultural water quality through Required Agricultural Practices, establishes water quality requirements for stormwater discharges from new and existing development, industrial and municipal stormwater discharges, and runoff from municipal roads. It also addresses water quality runoff from forest silvicultural activities and supports wetland restoration efforts.

Act 64 establishes the requirement that all water quality improvement actions undertaken by the State be integrated by means of Tactical Basin Plans, and establishes partnerships with Regional Planning Commissions, Conservation Districts, and other organizations to support this work.

To meet requirements for attaining these new standards the Clean Water Fund has been established, permit fees have been increased, and new supportive positions have been created within the Agency of Natural Resources (ANR) and the Agency of Agriculture, Food and Markets (AAFM).

Act 64 is being gradually implemented as procedures are drafted and legislative rule-making progresses. The resulting policies and procedures will take several years to be

fully implemented, and will ensure improved water quality throughout the state. For more information, readers should review the content of the Vermont Clean Water Initiative website at: http://dec.vermont.gov/watershed/cwi.

Regional Conformance

Regarding work with the Regional Planning Commissions, the Agency of Natural Resources (VANR) will work with the applicable regional planning commissions to develop an analysis and formal recommendation on conformance with the goals and objectives of applicable regional plans, see 10 V.S.A 1253(d)(2)(G). The overall role of the TBPs is not to determine where development should happen. This Tactical Basin Plan encourages communities to take protective measures that will restore, maintain and enhance water quality in all areas that in turn protect human health, ecological integrity, and water-based recreational uses. The TBP does not preclude any development that is consistent with municipal zoning, regional and municipal plans and with applicable State and federal regulations.

Basin Description

A watershed, or basin, is a distinct land area that drains into a specific waterbody either through stream flow or surface runoff. Mountain peaks and hillsides define the Basin 10 watersheds. Killington Peak is the northernmost edge, Ludlow Mountain or Okemo borders the south basin boundary and Mount Ascutney defines the basin to the east. The twenty-three towns encompassed in the Basin are a diverse array of landscapes from wilderness to urban, from Chateauguay-No Town in Bridgewater to downtown Springfield. The local concerns for water quality, flood resiliency, and watershed protection are as diverse as the landscape.

Basin 10 consists of two major watersheds in southeastern Vermont - the Ottauquechee River watershed and the Black River watershed. Both rivers flow from the Green Mountain range near Killington peak down to the Connecticut River, the Black meeting it at Hoyt's Landing in Springfield and the Ottauquechee reaching it in North Hartland east of the flood control dam. Almost 80% of the Basin is in forect cover, 10% in agriculture or parture/grass and 6.7% is developed.

The Ottauquechee River has a mainstem length of 38 miles and drains an area of 223 square miles. From Killington Peak the river drops 3900 feet in elevation down to the Connecticut River in Hartland.

The Black River, has a mainstem length of 40 miles and drains an area of 202 square miles. It is formed at the outlet of Black Pond in the town of Plymouth and drops 3040 feet in elevation from the top of Ludlow Mountian (Okemo) to Hoyts Landing in Springfield.

Basin 10 also includes the streams that flow directly into the Connecticut River between the mouths of these two larger rivers. Among these are the two Mill Brooks that run on the north and south sides of Ascutney Mountain and Spencer, Blood and Lulls Brooks. These direct tributaries flow through the Towns of Hartland, Reading, West Windsor, Windsor, Springfield and Weathersfield.

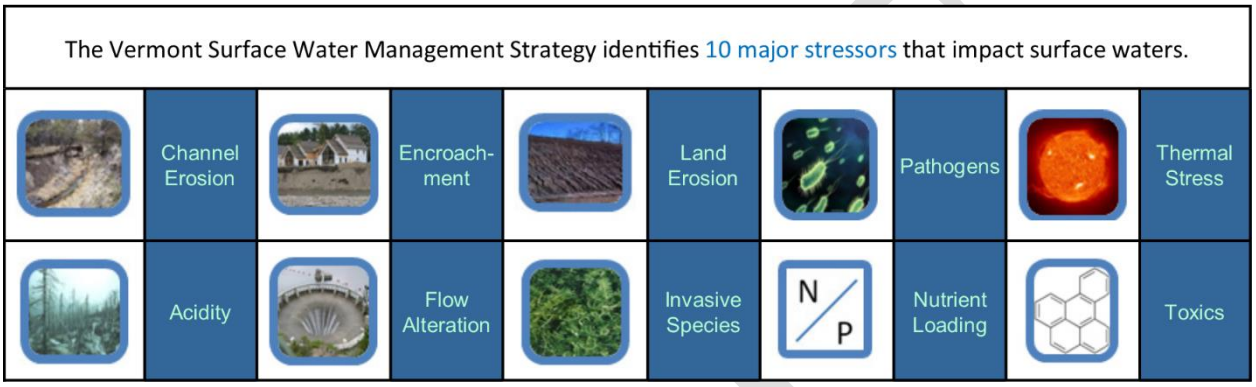
There are 19 lakes and ponds in the Basin that are 20 acres or larger covering approximately 1,610 acres. The North Springfield Reservoir, North Hartland Reservoir, Echo Lake, Lake Rescue, Lake Ninevah and Woodward Reservoir are the largest bodies of water in Basin 10, each being at least 100 acres in size.

Knapp Brook, Knapp Brook Wildlife Management Area Cavendish

Figure 1. ***Basin 10 Watersheds***

Chapter 2 – Water Quality in the Basin

Overview of Water Resources and Stressors



In developing the SWMS, the WSMD recognized that individual pollutants (often more than one) can be simultaneously mitigated by managing surface water stressors. The Division has identified a list of 10 major stressors with specific causes and sources, and sometimes overlapping effects, which result in the surface water impacts documented in Vermont. By identifying stressors and approaches to their management, the Strategy sets the stage for the WSMD's approach to multi-agency planning and implementation that will meet the WSMD goals.[2]

A stressor is defined as an observable influence with quantifiable damaging effects on surface waters resulting from the delivery of pollutants to a waterbody, or an increased threat to public health and safety. For the most part, stressors result from human activity on the landscape; however, when landscape activities are appropriately managed, stressors are reduced or eliminated.

Rivers

In the Ottauquechee River watershed the major pollutants include sediment, temperature, nutrients, and *E. coli*, as well as the impacts from physical alteration, flow alteration, and habitat alteration. Impairments are caused by stormwater runoff and

[2] SWMS, Chapter 1

iron seepage. The North Branch Ottauquechee maintains a high level of water quality and is an excellent fishery.

Pollutants impacting the Black River also include sediment, nutrients, E. coli and flow alteration dues to the flood control dams in North Springfield.

The Connecticut River tributaries are impacted by sediment and habitat alteration, while flow alteration impacts the entire Connecticut River mainstem.

Lakes and Ponds

Lakes and ponds in the region are impacted by low pH from acid rain and several have invasive species populations that impact lake uses and ecology. Encroachment of development along the lakeshore however is the most prevalent stressor with sedimentation and land erosion also impacting water quality.

Wetlands

Wetlands constitute only 1.8% of the Basin's land use. Extensive wetlands occur along the upper Ottauquechee and in association with the US Army Corps of Engineers flood control dams in both watersheds. While most are small to moderate in size there is a good diversity of wetland types in the Basin. As with lakes, encroachment and sediment from road runoff and erosion are major stressors to the regions wetlands.

Climate Change: increasing pollutant loads and impacts to waterbodies

Climate change predictions for Vermont are expected to intensify stresses on our watersheds, leading to increased pollutant loads from the landscape as well as loss of native species. Predictions include increased intensity and frequency of storms with resulting increases in stormwater flows which scour stream beds, impacting fish, macroinvertebrates and algal populations. In response, improved management of landscape activities will need to more effectively address the impacts of the additional flows and the resulting increases in channel and land erosion, nutrient loading and thermal stress.

Increased temperatures are also predicted, which will place further thermal stress on waterbodies and aquatic communities. Warmer temperatures will allow some invasive

species to gain a competitive edge, requiring changes in management strategies to better protect native species.

Summary of Surface Water Assessments

VANR and its partners conduct on-going monitoring and assessment throughout the Basin. Water quality, biological and physical assessments have been completed on many of the rivers, streams and lakes. VDEC uses monitoring and assessment data to assess individual surface waters in relation to Vermont Water Quality Standards as outlined in the 2016 VDEC Assessment and Listing Methodology.

Other types of assessments include stream geomorphic assessments (SGA), stormwater inventory and illicit discharge and detection studies and Total Maximum Daily Load (TMDL) plans. These efforts, as well as those planned for execution during the implementation of this Plan are detailed in Table 1.

Table 1. Completed Assessments

Sub-watershed	Date	Coverage
Stream Geomorphic Assessments		
Black River Corridor Plan	2009	Phase 1, 2 & Corridor Plan
Patch & Buffalo Brooks Corridor Plan	2010	Phase 1, 2 & Corridor Plan
Ottauquechee River Corridor Plan	2013	Phase 1, 2 & Corridor Plan
Roaring Brook Phase 1 and 2 SGA	2006	Phase 1, 2 Only
Mill Brook River Corridor Plan	2015	Phase 1, 2 & Corridor Plan
Hubbard Brook Phase 1 SGA	2008	Phase 1 Only
Water Quality and Aquatic Habitat Assessments		
Black River Watershed	2016	
Ottauquechee River Watershed including Mill Brook and Lulls Brook	2016	
Stormwater Assessments		
Town Stormwater Mapping and Stormwater Master Planning Reports	various	Barnard, Bridgewater, Cavendish, Chester, Hartford, Hartland, Killington, Ludlow, Plymouth, Reading, Springfield, Weathersfield, West Windsor, Windsor, Woodstock

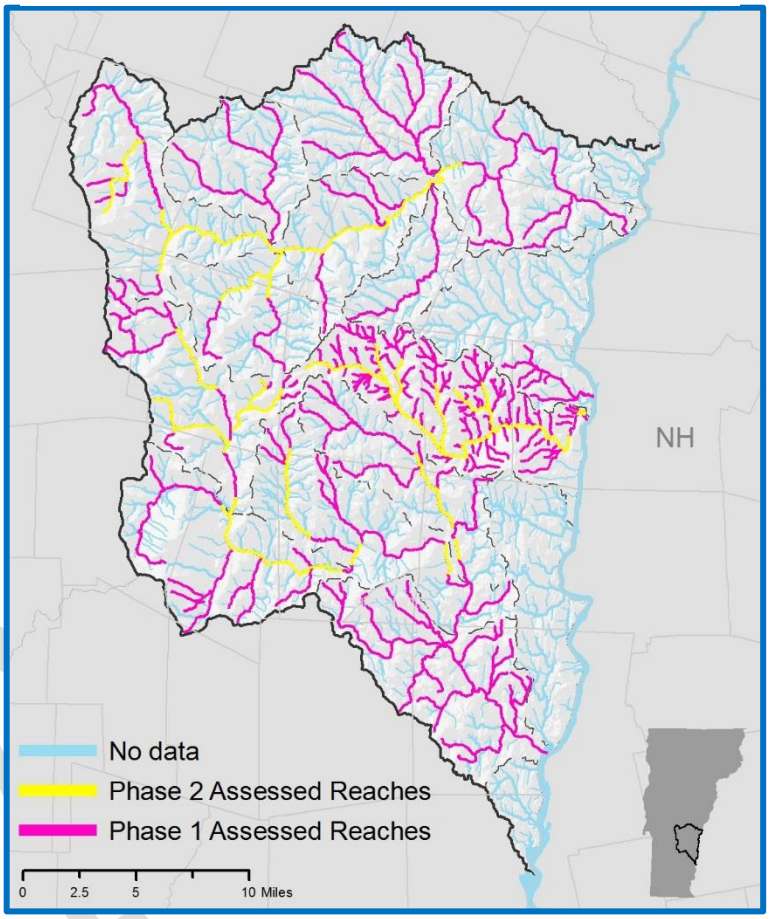
Town of Springfield Illicit Discharge Detection and Elimination Study	2013	Black River from St Mary's Cemetery to Seavers Brook & Chester Brook to Bellows Rd, Valley St to Litchfield Rd. & No. Springfield
TMDLs		
Black River - Phosphorus	2001	Below Ludlow WWTF for approx. 0.5 mi
Black River - Bacteria	2011	Springfield CSO[3]
Vermont - Mercury	2007	Statewide
Long Island Sound	2000	Multi-state
Water Quality Remediation Plan*	2011	Roaring Brook & East Branch of Roaring Brook

* Pursuant to 40 C.F.R. §130.7(b), the State may use a Water Quality Remediation Plan (WQRP) in lieu of a TMDL for an impaired water when the State determines that the pollution control requirements of the WQRP are stringent enough to meet State Water Quality Standards within a reasonable period of time.

[3] These waters are impaired for *E.coli* due to the influence of wastewater treatment facilities and combined sewer overflows. These waters are not covered under this TMDL but specifics regarding their location and management status is included in this document for informational purposes only.

Stream geomorphic assessments (SGA) study the physical conditions of rivers and the interralationships of flowing water and sediment within varying landscapes. SGAs incorporate watershed-wide information from maps, aerial photographs, existing studies, and field data into a detailed characterization of riparian and in-stream habitat, erosion, and flood hazards for use in watershed planning. Table 1 and Figure 2 show the locations and links for those completed in the Basin.

Figure 2. Stream Geomorphic Assessments



The Ambient Biomonitoring Program of the Watershed Management Division (WSMD) samples macroinvertebrate and fish communities in order to evaluate the biological health, or biological integrity, of rivers and streams and to identify high quality waters as candidates for reclassification. These surveys are used for detecting aquatic life impairments and assessing their relative severity. Biomonitoring assessments indicate the overall ecological integrity of the river system and provide a method of evaluating waters in comparison to their "reference condition" without human impacts. This program also collects water quality data that are used to assess compliance with Water Quality Standards. The biological and water quality results are used to rank the condition of waters as *Excellent, Very Good, Good, Fair* or *Poor*, using the Department's Procedures for Ambient Biomonitoring and Assessment.

The Lake Assessment Program of the WSMD performs similar functions for lakes and ponds, and numerous lakes and ponds have been assessed in this Basin. Figure 3 shows monitoring locations for both programs, and provides an assessment of current

biological integrity for streams. The condition of lakes is described separately in this Chapter.

A comprehensive summary of available assessment information from these and other processes is compiled into individual reports for each major watershed which details the conditions on a sub-watershed and reach level for the major watersheds in the Basin. These can be found at: http://dec.vermont.gov/watershed/map/basin-planning/basin10.

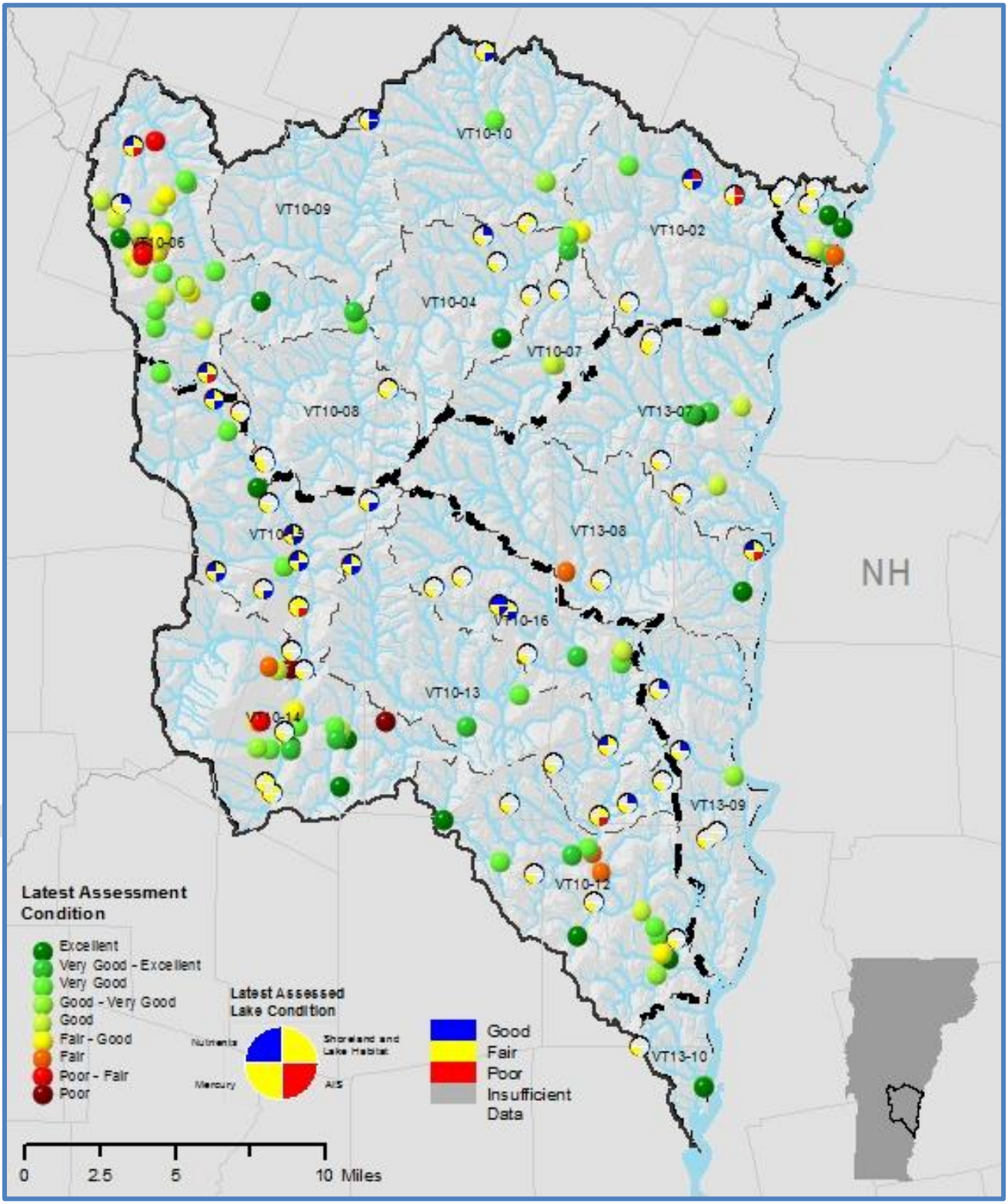
The Agency of Agriculture, Food and Markets assesses the need for **Required Agricultural Practices** (RAP) and **Best Management Practices** (BMPs) on agricultural sites through its farm inspection program. The level of assessment varies based on intensity of agriculture in the area. Initial assessments in Basin 10 are underway.

Condition of Specific Sub-watersheds

The Basin 10 planning unit includes the Ottauquechee and Black River watersheds, and the mainstem of the Connecticut River from the mouth of the White River in Hartford down to the mouth of the Williams River in Rockingham. All the smaller tributaries that drain directly into the Connecticut, such as the Mill Brooks in Windsor and Weathersfield, Lulls Brook in Hartland, Spencer Brook in Springfield and Blood Brook in Weathersfield are also now included in Basin 10.

The Watershed Management Division monitors river and steams on a five-year rotating schedule. The rankings below are based on the resulting biological, chemical and physical assessments. These rankings indicate compliance with Vermont Water Quality Standards (VWQS). Other forms of monitoring are conducted but compliance is based on the biological condition as evidenced through macroinvertebrate and fish community assessment data. Most of this data can be accessed through the Vermont Integrated Watershed Information System (IWIS), online data portal.

Figure 3. Biomonitoring Sites



Black River

Lower Black River – mouth to the North Springfield Reservoir dam

The lower 4.6 miles of the Black River, up to the Fellows dam, are impaired for contact recreation due to the persistence of combined sewers in Springfield. It is also impacted by altered flows due to the North Springfield reservoir and dam that increases water temperatures and siltation and degrades aquatic habitat. Additional pollutants include nutrient enrichment, bacteria, sediment, oils, metals and urban runoff. Significant water quality improvements have been observed in this reach with the recent biological assessments ranging from *Good-Very Good* to *Excellent* for **aquatic life support** (ALS).

***Figure 4. Lower Black** River*

Incorporation of phosphorus removal by the Springfield Wastewater Treatment Facility (WWTF) in 2004 has resulted in improved water quality conditions such that aesthetics of this reach are no longer assessed as impaired.

Two significant hazardous waste sites are located along the Black River. The closed Jones and Lamson manufacturing plant on the riverbank is in the **Brownfields** clean-up process with on-going remediation work. The buildings are to be removed and the site capped going forward. The closed Springfield landfill is a **Superfund** site along Seavers Brook.

Lower Black River – sub-watersheds

Several tributary streams have been assessed for aquatic life support these include:

- Seavers Brook – *Good-Very Good* – macroinvertebrates, *Very Good* – fish
- Mile Brook (Valley Street) – *Good*
- Chester Brook (Black Trib #9) – *Excellent* – macroinvertebrates, *Excellent* – fish
- Spoonerville Brook – *Very Good - Excellent* - macroinvertebrates
- Great Brook – headwaters – *Excellent* – macroinvertebrates, *Excellent* – fish

Unassessed tributaries to the North Branch:

Figure 5. Middle Black River

- Knapp Brook – Cavendish
- Alder Meadow Brook
- Darby Brook

Middle Black River – North Springfield dam to Cavendish dam

Recent monitoring of this reach reveals a community assessesed as *Very Good to Excellent*. The hydroelectric dam in Cavendish is operated as a **run-of-river** facility. This mode of operation maintains minimum flows levels and decreases the impacts on water temperture. The Cavendish WWTF discharges to the Black River in this reach.

The tributary stream assessed in the reach is:

- Tarbell Hill Brook – *Very Good* - macroinvertebrates

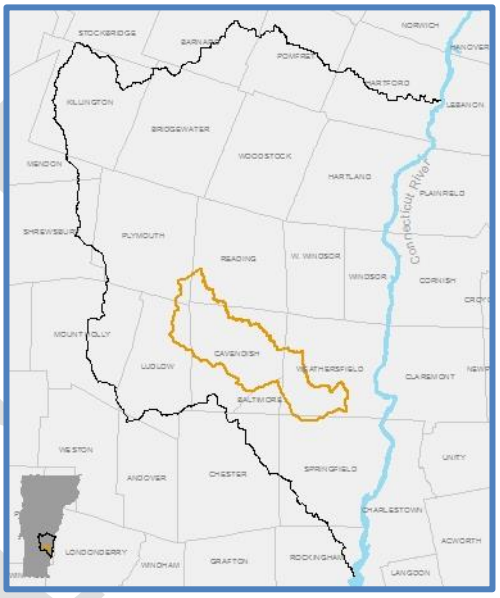


Figure 5a. Middle Black

Middle Black River –Cavendish dam to Branch Brook

The Ludlow WWTF discharges to the Black River in this reach. Monitoring above the dam/below WWTF rate the reach as *Very Good to Excellent* for macroinvertebrates. The WWTF does seasonal phosphorus removal to remove excess nutrients during the growing season.

Tributary streams assessed for macroinvertebrates in the reach include:

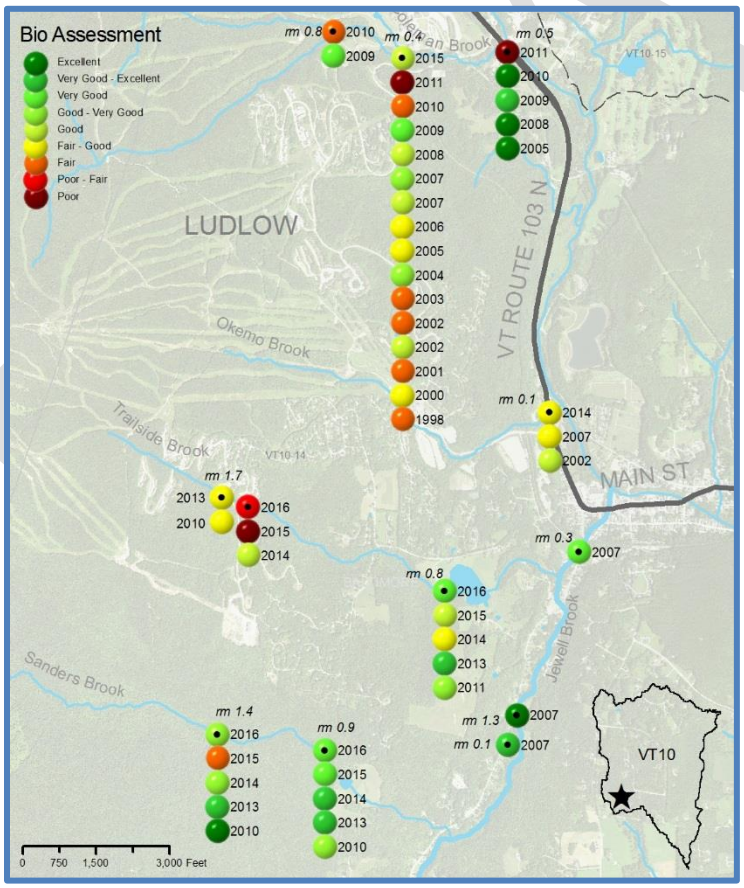
- Serpentine Brook (below quarry above North Star Hill Road) – *Poor*
- Coleman Brook – *Good*
- Jewell Brook – last monitored in 2007 at two locations when it was reported to be *Excellent* and *Very Good.*
- Okemo Brook – *Fair-Good*

Figure 5b. Middle Black

- Sanders Brook – the lower brook is rated as *Very Good-Excellent,* while the upper brook degraded from *Good-Very Good* in 2014 down to *Fair* in 2015. The cause of this change is not yet clear but may be due to altered streambed conditions.
- Soapstone Brook - *Excellent*
- Trailside Brook – ranges from *Good* to *Poor* along its length. Trailside Brook runs through Reservoir Number 3
- Branch Brook – *Poor* (2011) down from several years of *Excellent* ratings. Sampling was done shortly after Tropical Storm Irene, which likely scoured the stream bed, causing reduced numbers and diversity of macroinvertebrates resulting in a temporary asssessment of *Poor*. The stream has most likely recovered in the years since.

Several of these brooks are located within the Okemo Resort development as noted in Figure 6.

Figure 6. Okemo Biomonitoring Sites



Black River Headwaters – Branch Brook to headwaters

Figure 7. Black River Headwaters

Black River – *Very Good* for macroinvertebrates above Amherst Lake. This site is the most upstream monitoring site on the Black River mainstem and is also below the confluence of Money Brook. Fish sampling done in 2012 suggests some degradation in the overall community.

North Branch Black River - *Very Good – Excellent* for macroinvertebrates, *Fair* for fish. This site is the most upstream monitoring site on the North Branch.

Figure 8. North Branch Black River

Tributary streams assessed in the reach include:

- Great Roaring Brook - *Very Good* for macroinvertebrates, *Excellent* for fish
- Patch Brook - *Very Good* for macroinvertebrates
- Tarbell Hill Brook - *Very Good* for macroinvertebrates

Buffalo Brook was removed from the threatened category due to the new legislation in effect that discourages gold dredging.

Sherman Brook – tributary to the North Branch – In the fall of 2013 a road project caused a discharge of Styrene into Sherman Brook in Weathersfield. Follow up monitoring revealed that the pollutant levels in the water were extremely high. The communities were severely impacted. As shown in Figure 4. above the site the macroinvertebrate community was *Good*, just below the site it was reduced to *Poor*. Fifty meters downstream this community recovered to *Very Good* condition. Fish sampling above the impact site counted 33 Brook trout while below the site no trout were found. Clean-up efforts were put in place to capture and remove as much of the chemical as possible. A 2016 fish survey shows fish populations had recovered.

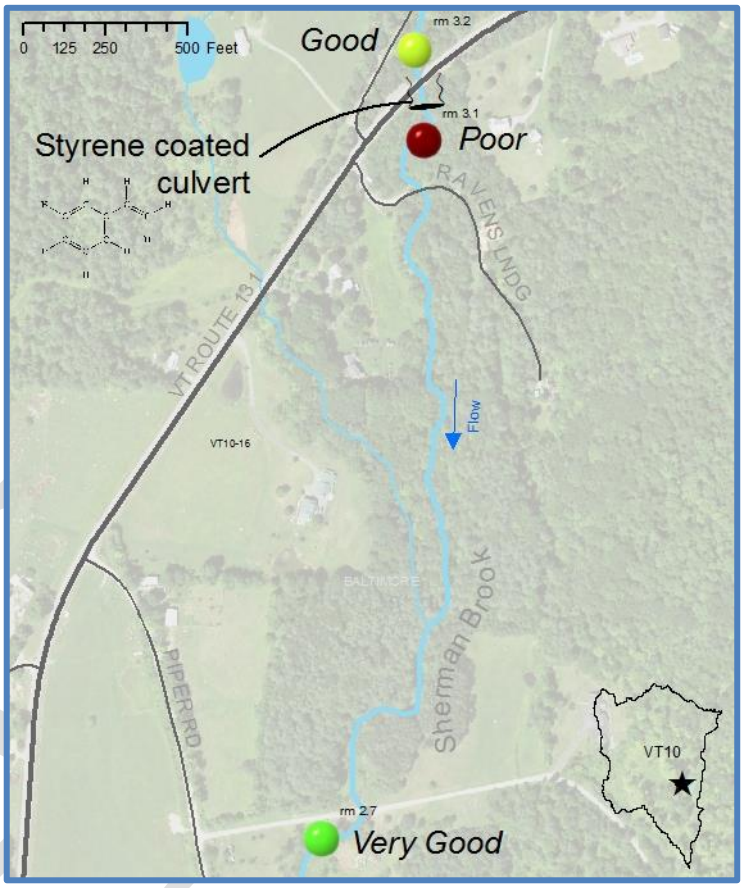


Figure 9. Sherman Brook Biomonitoring Sites

Ottauquechee River

Lower Ottauquechee River – mouth to Kedron Brook

The lower Ottauquechee River system is dominated by six dams. Beginning at the river mouth is the White Current dam in Hartland. Farther upriver are the USACE flood control dam in North Hartland and the Deweys Mill dam in Quechee, all three of these dams provide hydroelectric generation. Deweys Pond and Quechee Mills dams and the off-river Lake Pinneo dam provide recreational opportunities. The uppermost Taftsville dam is also power producing.

The flow alterations caused by the dams impact aquatic life, recreation and aesthetics of the reach which is listed as *Altered* from the upper end of the North Hartland reservoir to the Connecticut River. The remainder of the reach is listed as Stressed for these uses due to nutrients, organic enricment, temperature, sediment and *E. coli*.

The reach is stressed from Woodstock village to the reservoir for secondary contact recreation, aquatic biota/habitat and aesthetics due to nutrients, organic enrichment, temperture, sediment, and *E. coli*, from golf course, road, and developed land runoff, septic systems and fertilized turf.

From Bridgewater Corners to Woodstock village it is stressed for sediment, physical alteration, temperature from road encroachments and runoff, and an over-wide channel.

Figure 10. Lower Ottauquechee River

Permitted wastewater discharges to the reach include the Quechee, Sherburne, Taftsville and Woodstock wastewate treatment facilities (WWTF) and the disposal field for the Sunrise Village development in Killington.

Figure 11. Barnard Brook

Tributary streams assessed for macroinvertebrates in the reach include:

- Barnard Brook – Stressed for sediment and temperature from unknown sources – *Good-Very Good*
  - Gulf Stream – Stressed for sediment from gravel road maintenance
- Harlow Brook – *Good*

Figure 12. Kedron Brook

- Kedron Brook – Stressed for sediment, nutrients and bacteria caused by horse recreation activity; pasture; road runoff; loss of riparian vegetation; and a golf course
  - *Very Good* at its mouth
  - *Very Good-Excellent* below the golf course
  - *Good* above the So. Woodstock WWTF
  - *Good* below the So. Woodstock WWTF

Middle Ottauquechee River – Kedron Brook to Broad Brook

This reach while assessed for macroinvertebrates at *Excellent* and *Very Good* along its course, is stressed from Woodstock to Bridgewater Corners vicinity for aquatic habitat, aesthetics, and secondary contact recreation. The stressed conditon results from physical alteration of the channel and the lack of riparian vegetation creating a wide and shallow channel with high water temperatures.

A small unnamed tributary draining the closed Bridgewater landfill enters this reach and is listed as impaired for leaching metals into the river.

Over 350 acres of wetlands along Route 4 help protect the water quality of the river and provide wildlife habitat and flood prevention.

North Branch Ottauquechee River – *Very Good-Excellent* for macroinvertebrates

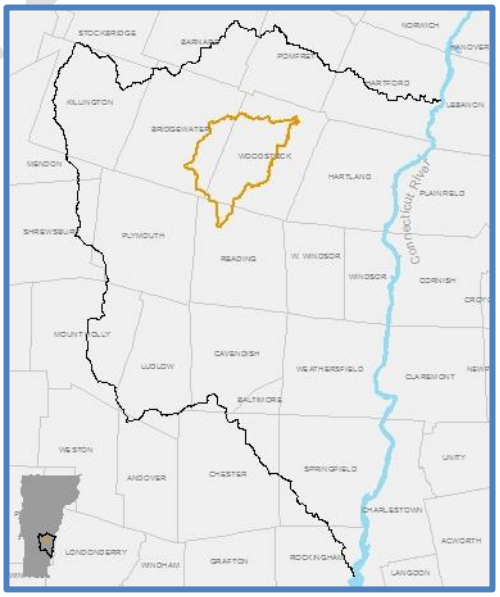


Figure 13. Middle Ottauquechee River

The North Branch of the Ottauquechee River is being put forth in this plan for designation as an Outstanding Resource Water and reclassification to Class A(1) or B(1) for its fishery and aquatic biota and habitat. More data needs to be gathered for full documentation but the current data show the biota to be of very high quality and the habitat in excellent condition. The land in the watershed is almost completely forested and the majority of the land is protected by either public ownership (6,700 acres), private conservation (6,890 acres) or is under restrictions through the Use Value Appraisal or Current Use program.

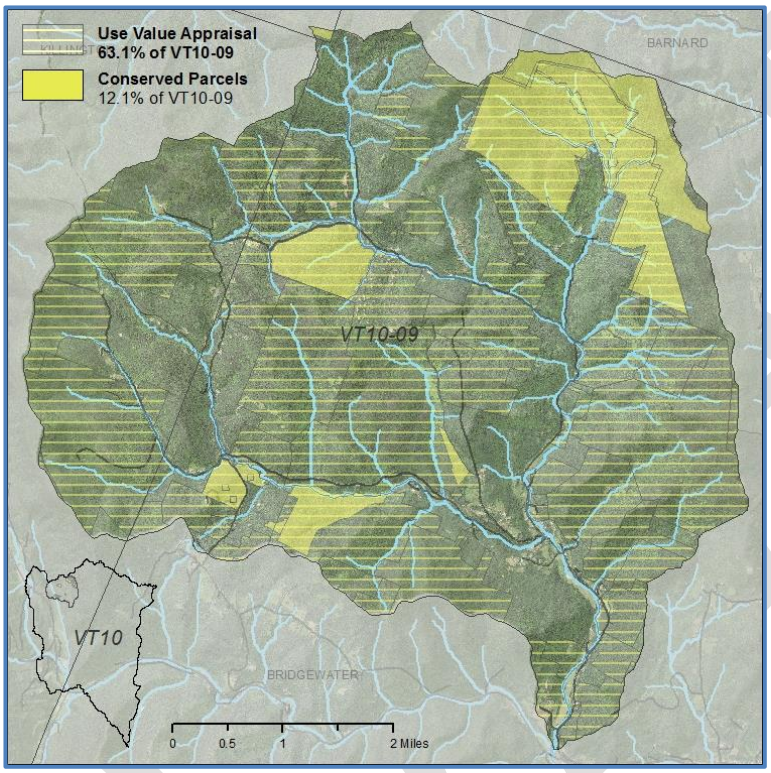


Figure 14. North Branch Ottauquechee River and Conserved

The Chateauguay No Town Conservation Project is a four town conservation partnership to protect the 60,000+ acre Chateauguay No Town (CNT) Area. The multi-town partnership in Barnard, Stockbridge, Bridgewater, and Killington features collaboration between town officials, non-profit organizations, and private landowners to protect the critical natural resources of CNT and to maintain its relatively undeveloped landscape. The maintenance of CNT assists and encourages private landowners in voluntary conservation mechanisms; promotes sustainable forestry; preserves the ecological integrity of the area's natural resources; conserves critical

wildlife habitat areas for bear, moose, and plant communities; and protects the upland watersheds of the Ottauquechee and White Rivers.

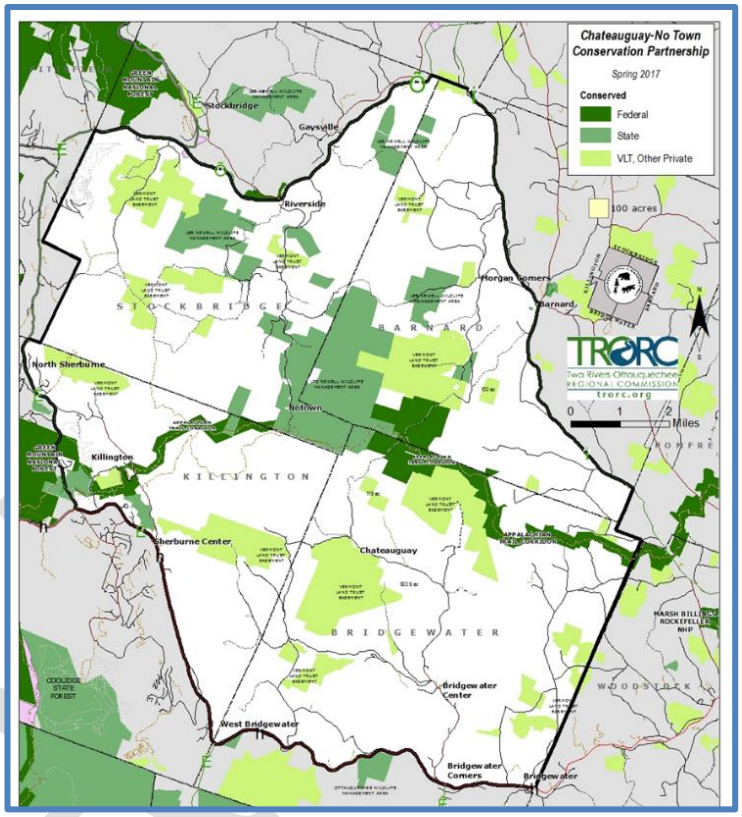


Figure 15. Chateauguay-No Town Conservation Project

Tributary streams assessed for macroinvertebrates in the reach include:

- Broad Brook – Stressed for sediment and physical alterations caused by streambank erosion, channelization, and past gold dredging
- Beaver Brook – *Excellent*
- Falls Brook – Stressed for sediment caused by land development; erosion; and streambank destabilization
- Bridgewater landfill tributary – Impaired for heavy metals from landfill leachate in a wetland draining to small stream to the Ottauquechee River

Upper Ottauquechee River - Broad Brook to headwaters

Geomorphic assessment of the mainstem river shows it to be stressed for sediment, physical alteration and temperature due to pre- and post-Irene channelization, road encroachment and runoff, causing the channel to be over-wide. However, biomonitoring sites through the reach rank the river as *Very Good* to *Excellent.* This region also benefits from extensive wetlands that run adjacent to Route 4 from the Bridgewater/Killington town line up to the headwaters.

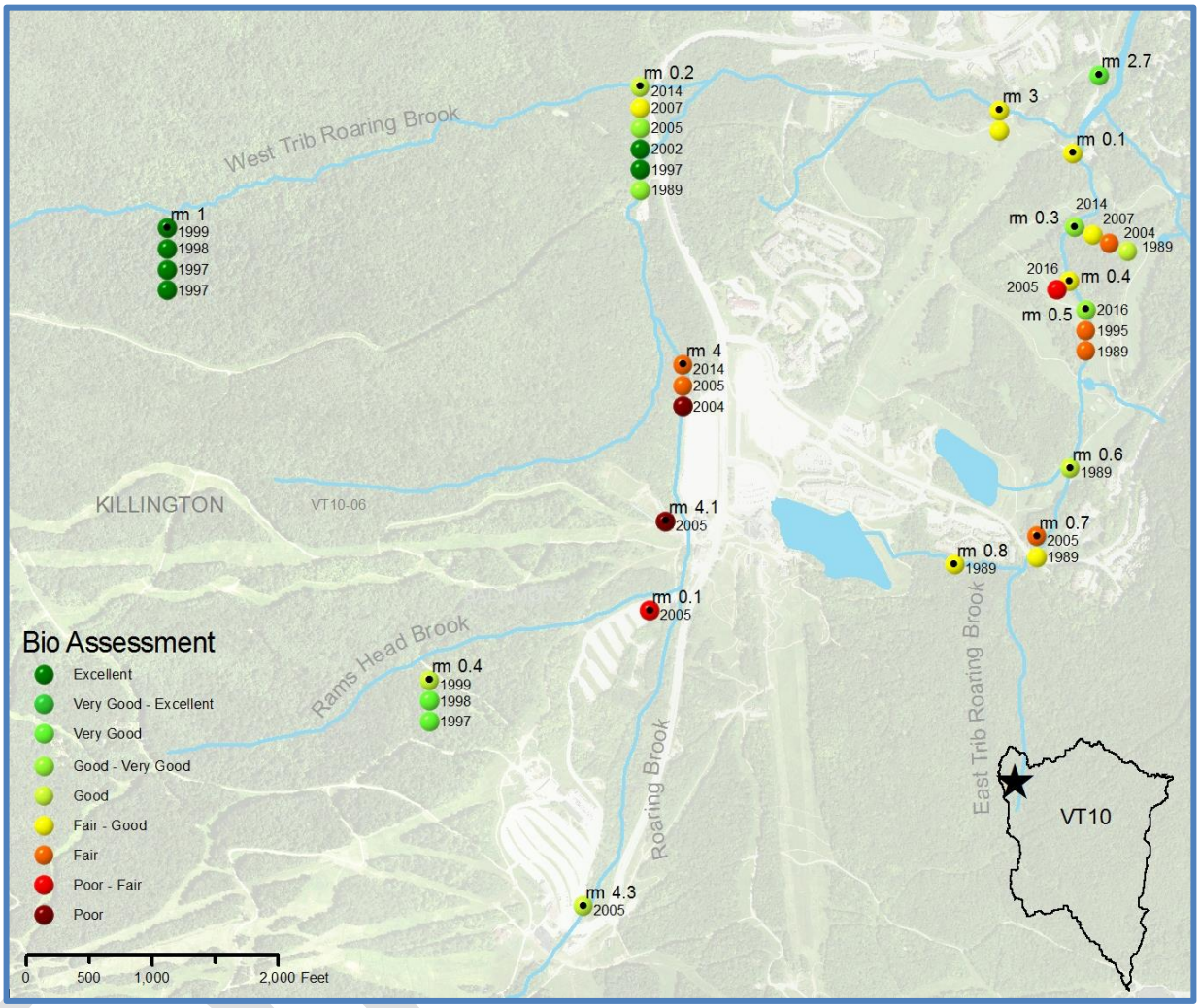
Figure 16. Upper Ottauquechee River

Tributary streams assessed for macroinvertebrates in the reach include:

- Madden Brook - *Good*
- Roaring Brook – Impaired for stormwater from runoff, land development and erosion.
    - Near base lodge – Stressed – *Good*
    - Near junction of E. Mountain Rd – *Poor*
    - East Branch Roaring Brook – Impaired for stormwater and iron caused by stormwater runoff, land development, and erosion – *Fair-Good*
    - West Branch Roaring Brook – Impaired for sediment from land development; erosion and road runoff – above Killington Rd – *Good*
    - Upper Roaring Brook and West Branch (Approx. 1.2 Miles) – Stressed for sediment from land development; erosion; and road runoff.

Figures 17. shows the conditions in the impaired Roaring Brook branches.

Figure 17. Roaring Brook Biomonitoring Sites



Supporting data on the water quality of the river is also provided by the Ottauquechee River Group (ORG). ORG has been monitoring the watershed since 2010 for bacteria, nitrogen, phosphorus, turbidity and chloride. Sampling locations are listed below in Table 2. Included in their 2016 summary report covering six years of monitoring is Table 3 which shows sites of concern for each parameter tested. This reveals that phosphorus levels throughout the river are of concern, as are chloride in the upper river.

Table 2. Ottauquechee River Group Monitoring Sites

Ottauquechee River Group Monitoring Sites			
Ottauquechee River:		Tributaries:	
Site Name	Site Number	Site Name	Site Number
Hartland covered bridge swim area	OtR006	Kedron Brook below Horse Stables	KeB032
Below Quechee WWTF	OtR070	Kedron Bk below WWTF	KeB045
Below Taftsville WWTF	OtR132	Kedron Bk above WWTF	KeB046
Above Taftsville Dam	OtR133	Kedron Brook above GMHA	KeB057
Below Woodstock WWTF	OtR157	North Branch/Otto Confluence	NBO001
Above Woodstock WWTF	OtR163	Falls Bk/Otto Confluence	FaB002
Behind Woodstock Union HS	OtR185	Roaring Bk above Roaring/Otto Confluence (just u/s Route 4 bridge)	RoB002
Below Bridgewater WWTF	OtR245	Roaring Bk/Mtn View Rd. crossing	RoB010
Route 100A Bridge	OtR254	Roaring Brook above WWTF (just u/s of Ravine Road bridge)	RoB028
Rabeck Road Bridge	OtR384		

Table 3. ORG 6-Year Summary

Site ID	Parameter				
	TP	TN	Cl-	E. coli	TURB
OtR006	XXXX				
OtR070	XX				
OtR132	XX			X	
OtR133	XXX			X	
OtR157	XXX				
OtR163	X				
OtR185	X				
OtR245					
OtR254	XX		XX		
OtR384	XXXX		XXXXX		
FaB002	X		XX		
KeB045	XXX			XX	
KtB015					
NBO001					
RoB010			XXXXX		

Each X indicates the average of one season of data that exceeded expected levels for that parameter

TP – total phosphorus
TN – total nitrogen
Cl – Chloride
E. coli – bacteria
TURB - turbidity

Connecticut River and tributary streams

Connecticut River – White River Junction to Springfield

The reach of the Connecticut River mainstem covered in the Plan is impaired due to the flow alterations created by the operation of the hydroelectric dams at Wilder and Bellows Falls. The altered hydrology impacts aquatic life support. Vermont conducts very limited assessment of the Connecticut River and depends on monitoring by New Hampshire Department of Environmental Services. New Hampshire lists this reach as impaired for Aquatic Life due to low pH.

One site near Johnson Island in Hartford is assessed as *Fair* for macroinvertebrates.

Tributaries to the Connecticut River – – (listed from north to south)

Tributary streams assessed for macroinvertebrates in the reach include:

Kilburn Brook – in 2009 – *Good* and in 2015 - *Excellent*

Neal Brook – Hartford - drains the closed Hartford landfill site – Impaired for metals

- 2015 – *Fair* above the tributary draining the landfill and below I-91
- 2015 – *Poor* below the landfill tributary, decreased from *Fair* in 2009
- 2015 – *Fair* another 1500 feet downstream

Lulls Brook – Stressed for sedimentation from gravel road runoff & other sources; needs additional assessment. Upstream from below Weed Road to downstream at Bishoff Lane the stream goes from *Excellent* to *Good*.

Figure 18. Hartland-Windsor Direct

Hubbard Brook – 2003 - *Good*

Mill Brook – Windsor

- 2008 – *Excellent* at Rt 44 in Windsor
- 2014 – *Fair* at Rt 44 in West Windsor below old talc mine

- Mill Brook is listed as Stressed from the Mill Pond dam to the Connecticut River for sedimentation from dam work and stormwater from development.
- It is also listed as Stressed from Willow Brook down to Mill Pond for sediment and habitat alteration due to streambank erosion and road runoff.
- The Mill Pond (Windsor Upper) dam at the outlet of Mill Pond was inspected in 2016 and is rated in Poor condition. This is a High Hazard Dam meaning that a dam failure "may cause serious damage to homes, as well as extensive damage to the agricultural, industrial and commercial facilities, important public utilities, main highways or railroads. The potential economic loss is extensive and there is a high potential for loss of life." The Town of Windsor continues to work on securing the structure.
- A River Corridor Plan was completed in 2015 providing over 60 potential restoration projects along the brook. The priority projects are listed in the Implementation Table in Chapter 4.

Figure 19. Mill Brook

Blood Brook – *Good/Very Good* for macroinvertebrates, *Excellent* for fish

Lakes and Ponds

There are a total of 43 lakes and ponds of 10 acres or larger in the Basin totaling approximately 2,172 acres. North Springfield Reservoir, North Hartland Reservoir, Lake Rescue, Lake Ninevah, Woodward Reservoir and Echo Lake are the largest, each being at least 100 acres in area. Others of note include Amherst Lake, Stoughton Pond, Deweys Mill Pond*, Lake Pinneo*[4], the Knapp Brook ponds, Colby Pond, Black Pond, Lakota Lake and the Pogue.

Several deserve mention for their special features.

Black Pond, Plymouth: This 20-acre private pond constitutes the headwaters of the Black River. Despite being relatively close to VT Route 100, it has a secluded

[4] * - these are constructed ponds

feeling, and the majority of the shoreline is forested. There exists an unusual cluster of boulders on the shoreline which provide for scenery of statewide significance.

Echo Lake, Plymouth: This 104-acre lake has supported two rare native species of watermilfoil: *Myriophyllum alterniflorum*, which was last observed in 1985, and *M. farwelli*, which was last seen in 1990.

Kent Pond, Killington: At one time, 99 acre Kent Pond was characterized by poor water quality, with excess algae growth throughout the pond. However, recent assessments show improved water quality conditions and decreased spring phosphorus levels. It does however host a Eurasian watermilfoil population.

Woodward Reservoir, Plymouth: This impounded 106-acre lake has an adjacent palustrine wetland characterized by a floating bog mat. This is a significant feature, and is rare in the Black and Ottauquechee River Basin. It also provides rare Dwarf Shrub Bog habitat.

Lake Ninevah, Mount Holly: This 171-acre, high elevation lake is significant for a variety of reasons. While the lake is developed along approximately one third of its northern shoreline, the remainder is undeveloped and protected forested land. The watershed of the lake is also completely forested. The southern portion of the lake is bordered by a 56-acre wetland which has significant habitat value for both wildlife and other aquatic biota. The lake is a long-term loon (*Gavia immer*) nesting site and hosts a number of rare species including Farwell's Water-milfoil *(Myriophyllum farwellii*), Slender Naiad (*Najas gracillima*) and the rare pondweeds Bluntleaf Pondweed (*Potamogeton obtusifolius*) and Tuckerman's Pondweed (*P. confervoides*). 115 species of birds have been observed here as well. Over 60 acres of wetlands are contiguous to the lake hosting Sweet Gale Shoreline Swamp, Poor Fen and Intermediate Fen natural communities. Eurasian watermilfoil is monitored and controlled through hand-pulling by divers. Lake landowners are working to re-establish the Lay Monitoring Program and conduct invasive plant surveys.

The Pogue, Woodstock: This small 11-acre pond has become part of the Marsh-Billings-Rockefeller National Historic Site, and as such is now under the protection and stewardship of the National Park Service.

Deweys Mills Pond, Quechee: This impoundment was originally created by construction of a dam on the Ottauquechee River in the early 1900s. In the 1970s, a dike was built to separate the impoundment from the river. The current 56-acre impoundment is managed specifically to support waterfowl and wildlife uses. The pond is characterized by dense macrophyte cover, with significant shallow areas. Eurasian watermilfoil has become a problem in the pond which has led to chemical treatment and hand-pulling efforts.

Mill Pond or Kennedy Pond, Windsor: At 77 acres, Mill Pond is the largest pond in the Connecticut River tributary watersheds. It is listed as Altered due to the presence of Eurasian watermilfoil and is impacted by Phragmites and Purple loosestrife all of which are invasive. The pond hosts the town beach and large recreation area with trails along the 45 acres of contiguous wetlands. Several uncommon species are present in the pond and wetlands including:

- Guadalupe naiad (*Najas guadalupensis),* **S2**
- Slender Naiad (*Najas flexilis*), S2
- Slender Paspalum (*Paspalum setaceum var. muhlenbergii*), S2
- Bald Eagles (*Haliaeetus leucocepahlus*) are also a common sight and nest nearby.
- 72 species of birds have been documented including Great Egret (*Ardea alba)*

Lake Runnemede or Evarts Pond, Windsor covers 62 acres. While classified as Class B, the lake is part of the town's Wellhead Protection area and recreational uses are limited to protect the water quality. About 60 acres of wetlands, including those in Paradise Park, are contiguous to the lake. The **S1** species Ogden's Pondweed (*Potamogeton x ogdenii*), is present as is Marsh Horsetail (*Equisetum palustre*), S2. The 200 species of birds documented here include American Pipit, Marsh Wren, Bobolink, Cliff Swallow, Common Loon, Bonaparte's Gull, Horned Lark, Nelson's Sparrow, Red-throated Loon, and Orchard Oriole.

Muckross Pond, Springfield: while only 15 acres in size Muckross Pond is one of the newest waterbodies under State ownership. As of 2017, the pond and the surrounding 204 acres have become Muckross State Park. Preliminary investigations by the Black River Action Team have discovered fresh water sponge, bryozoans and a new-to-Vermont species of dragonfly.

The North Hartland and North Springfield Reservoirs and Stoughton Pond are listed as Altered by flow regulation due to their flood control dams. The latter two have no biologically based conservation flow requirements in their permit conditions. Lack of flow alters aquatic habitat. The North Hartland dam is also used for hydropower production. Invasive Water chestnut was found in North Springfield Reservoir a few years ago, and has been managed by hand-pulling efforts ever since. Dense Eurasian watermilfoil populations were found in North Springfield Reservoir and Stoughton Pond in 2017.

Lake and pond water quality and habitat conditions are monitored through numerous WSMD programs including the Spring Phosphorus and Lake Assessment, Long Term Monitoring of Acid Lakes, and by the Lay Monitoring Program among others. While many lakes and ponds fully support the requirements of the VWQS, many others are impacted by acidification, and several exhibit high levels of mercury in fish. Both issues result from atmospheric deposition of pollutants from sources outside of Vermont.

Acid deposition is rain, snow, fog or dust that is polluted by acid in the atmosphere and damages aquatic and terrestrial systems. Two common air pollutants acidify the water or dust particles: sulfur dioxide (SO2) and nitrogen oxide (NO_X). When these substances are released into the atmosphere, they can be carried over long distances by prevailing winds before returning to earth as acidic precipitation. When the environment cannot neutralize the acid being deposited, damage occurs. Lakes and ponds are especially vulnerable to this damage. Due to weather patterns and topography two-thirds of the acid impaired lakes are in southern Vermont.

Lake-specific information is compiled in the Vermont Lake Score Card, which has been developed to convey a large amount of data on four key aspects of lake health: nutrients, aquatic invasive species, shoreland condition and lake habitat. The 2017 Scorecard also includes mercury pollution and a Watershed Disturbance Index which is a measure of human-induced alterations to the biological, chemical and physical

processes of a watershed's lands that impact the lake. Table 4 provides an assessment of individual lakes from the Vermont Lakes Scorecard.

Table 4. Lake Score Card

	= Good Conditions	≤ 0.2
	= Fair Conditions	0.2 – 0.75
	= Reduced Conditions	≥ 0.75
	= Unassessed	

Lake ID	Lake Area(acres)	Town	WQ Trend	WQ Status	AIS 2015	2015 Mercury	2015 Shoreland	Watershed (LDI)
AMHERST LAKE	81	Plymouth						1.31
BLACK POND	20	Plymouth						1.6
CARLTON RESERVOIR	4	Woodstock						
COLBY POND	20	Plymouth		pH				2.25
COOK POND	3	Ludlow						
COX RESERVOIR	2	Woodstock						
CRYSTAL POND	2	Hartland						
DEWEYS MILL POND	56	Hartford						2.18
ECHO LAKE	104	Plymouth						1.3
GOULDS; MUCKROSS POND	6	Springfield						
GRAHAMVILLE; (Golf course)	8	Ludlow						3.08
GRASS POND	3	Plymouth						
JEWELL BK #1;	14	Ludlow		pH				1.71
JEWELL BK #2;	17	Ludlow						1.22
JEWELL BK #3;	18	Ludlow						1.87
KENT POND	99	Killington						1.42
KNAPP BROOK #1	25	Cavendish		pH				1.16
KNAPP BROOK #2	35	Cavendish		pH				1.17
LAKOTA LAKE	20	Barnard		pH				1
LINE POND	10	Barnard						1.29
LOWER MOORE POND	5	Plymouth						1.02
MECAWEE POND	11	Reading		pH				1.06
NINEVAH, LAKE	171	Mount Holly		pH				1.18

Lake ID	Lake Area(acres)	Town	WQ Trend	WQ Status	AIS 2015	2015 Mercury	2015 Shoreland	Watershed (LDI)
NORTH HARTLAND RESERVOIR	215	Hartland		Flow alteration				1.57
NORTH SPRINGFIELD RESERVOIR	290	Springfield		Flow alteration				1.57
PICO POND	12	Killington		pH				1.09
PINNEO, LAKE	50	Hartford						4.33
READING POND	22	Reading		pH				1
RESCUE LAKE	184	Ludlow						1.3
RESERVOIR POND / LAKE PAULINE	32	Ludlow						1.32
SOUTH MECAWEE POND	2	Reading						1
SOUTH READING;	12	Reading						1.46
SPOONERVILLE POND	8	Chester						1.64
SPRINGFIELD	10	Weathersfield						1.84
STOUGHTON POND	56	Weathersfield		Flow alteration				1.46
THE POGUE	11	Woodstock						1.54
TINY POND	29	Ludlow						1.15
UPPER MOORE	3	Plymouth						
VIEW POND	4	Woodstock						
VONDELL	10	Woodstock						1.15
WOODWARD RESERVOIR	106	Plymouth						1.29

Connecticut River

Lake ID	Lake Area(acres)	Town	WQ Trend	WQ Status	AIS 2015	2015 Mercury	2015 Shoreland	Watershed (LDI)
BEAVER POND	49	Weathersfield						1.39
COOKS POND	10	Weathersfield						1.73
MILL POND	77	Windsor						1.73
RUNNEMEDE, LAKE	62	Windsor						2.36

Table 5. Known Invasive Plant Populations			
Lake	**Town**	**Control Methods**	**Invasive**
DEWEYS MILL POND	Hartford	Diver-operated suction harvesting; Hand pulling	Eurasian watermilfoil
KENT POND	Killington	None	Eurasian watermilfoil
LAKE NINEVAH	Mount Holly	Controlled since 2011	Eurasian watermilfoil
LAKE PINNEO	Hartford	Herbicide permit	Eurasian watermilfoil
LAKE RESCUE	Ludlow	Diver-operated suction harvesting; Hand pulling	Eurasian watermilfoil
LINE POND	Barnard	None	Eurasian watermilfoil
MILL/KENNEDY POND	Windsor	None	Eurasian watermilfoil
NORTH HARTLAND RESERVOIR	Hartland	Hand pulling	Eurasian watermilfoil
NORTH SPRINGFIELD RESERVOIR	Springfield	Hand pulling	Water chestnut
Rivers			
BLACK RIVER (lower)	Springfield	None	Rusty crayfish
HOYTS LANDING (Black River)	Springfield	None	Eurasian watermilfoil, Curly-leaf pondweed
CONNECTICUT RIVER	Many	None	Eurasian watermilfoil, Curly leaf pondweed, Purple loosestrife, Japanese knotweed
OTTAUQUECHEE RIVER (lower)	Hartland	None	Purple loosestrife, Japanese knotweed

The Vermont Legislature passed the Shoreland Protection Act for lakes and ponds, effective July 1, 2014, that regulates activities within 250 feet of the mean water level of lakes greater than 10 acres in size. The intent of the Shoreland Protection Act is to allow reasonable development along shorelands of lakes and ponds while protecting aquatic habitat, water quality, and maintaining the natural stability of shorelines. Standards for the creation of impervious surfaces (such as buildings and driveways) and cleared areas within the shoreland area are intended to preserve functioning lake ecosystems, protect water quality, bank stability, conserve aquatic and wildlife habitat, and further the economic benefits of lakes and their shorelands. Guidance on implementing the requirements of the Act is provided in A Handbook for Shoreland Development.

Wetlands

Eshqua Bog (Hartland) is 8 acres within a 41 parcel. Though not mapped as a wetland it is technically a Rich Fen, containing Showy lady's slipper (*Cypripedium reginae*), Yellow lady's slipper (*Cypripedium pubscens*), Northern Bog orchid (*Plantanthera huronensis*) and Green orchid (*Platanthera hyperborean*), as well as numerous dragonfly species and 69 documented bird species. The unique wetland is co-owned and managed by The Nature Conservancy of Vermont and the New England Wild Flower Society. A boardwalk and trails provides visitor access for viewing a variety of plants and animals.

Killington Flats (Killington) Stretching almost 8 miles, over 400 acres of contiguous wetlands provide vital floodwater storage and wildlife habitat through the Route 4 valley below Killington Mountain. 99 species of birds have been documented including Swamp sparrow (*Meliospiza georgiana*), Hermit thrush (*Catharus guttatus*), American bittern (*Botaurus lentiginosus*), Black duck (*Anas rubripes*), Lincoln's sparrow (*Melospiza lincolnii*), Wilson's snipe (*Gallinago delicata*), and Virginia rail (*Rallus ilimicola*).

Three wetlands have also been identified as potential restoration sites due to the habitat alterations and invasive plant populations. Two are former wetlands converted to agriculture, one adjacent to the Connecticut River on River Road in Springfield and one by the North Branch of the Black River along Route 106 in Weathersfield. The third called Upper Meadows is also on the Connecticut River along Route 5 north of Bellows Falls.

Fisheries Description

Fisheries, as used here, are those activities related to recreational fishing. Fish community assessments as they relate to aquatic life support are included in the river biological assessments.

The **Black River** basin supports a wide variety of both warm and cold-water fisheries. The mouth of the Black River and its lower reach contains many warm-water fish species as are commonly seen in the Connecticut River. The lower portion of the Black River and its lower tributaries also serve as spawning areas for wild rainbow trout populations residing in the Connecticut River and native anadromous sea lamprey, which migrate up the Connecticut River from the Atlantic Ocean. Species of greatest conservation need (SGCN) including redbreast sunfish and anadromous American shad also utilize the lower Black River downstream of the Lovejoy Dam, although the number of American shad that have passed above the Bellows Falls fish ladder has only begun to increase in recent years.

Upstream portions of the Black River mainstem and its tributaries above the Cavendish Dam, are managed for wild brook trout (a SGCN), and brown trout populations. However, portions of the Black River mainstem downstream of the dam are managed as a "put and take" fishery due to high water temperatures throughout the summer months which prevent the establishment of wild trout populations or the long-term survival of stocked trout. Average water temperatures measured on the Black River mainstem in Weathersfield by the Vermont Department of Fish and Wildlife in 2015 at 622-feet in elevation above sea level generally exceeded 70°F throughout the summer, and maximum seven-day mean water temperatures commonly reached nearly 83°F (Will 2016; Figures 1, 4). Temperatures above 70°F are unsuitable for brook trout. Brown trout can tolerate warmer temperatures up to 80°F, but only for short periods of time.

A variety of fish species exist within the **Ottauquechee River** basin, many of which support a popular recreational fishery. Naturally reproducing (wild) native brook trout are common in colder, higher elevation tributaries and within the mainstem above West Bridgewater. Wild non-native populations of brown trout and rainbow trout are less common, but present within individual tributaries and mainstem reaches. The mainstem below West Bridgewater supports low wild trout populations, likely due to temperature limitations and poor habitat quality. In 2016, VDFW (Vermont Department

of Fish and Wildlife) observed mainstem water temperatures exceeding 80°F at seven locations between Bridgewater and Hartford and maximum temperatures exceeded 85°F above Dewey's Mill Pond (upper end of Highland Golf Course). In 2005, maximum water temperature at the same location exceeded 88°F and reached 80°F or above on 29 days. Hatchery-reared trout are stocked annually by VDFW within the Ottauquechee River from Bridgewater Corners (Junction of Rt.4 & 100) to the Taftsville Dam and provide angling opportunity in areas with limited wild trout populations. Tributary streams are not stocked and managed as wild trout waters.

Mill Brook is considered a cold-water fishery and supports native populations of brook trout and non-native brown trout. Population estimates from two annual sampling sites on Mill Brook in recent years indicate trout populations are generally stable, but low relative to more productive waters in the state. Brook trout are currently stocked annually through an approximately 1.2 mile stretch of Mill Brook along the West Windsor and Reading town line. Other fish species present in Mill Brook include northern redbelly dace, fathead minnow, blacknose dace, longnose dace, white sucker, longnose sucker, creek chub, and slimy sculpin.

Mill Brook and the Ottauquechee River have impassable dams cutting off fish passage from the Connecticut River within one mile of the confluence. The first dam on the Black River is four miles up from the mouth. These obstructions prevent native Brook trout and anadromous sea lamprey and shad from reaching spawning areas and accessing cooler water when Connecticut River temperature rises.

Excessively high summer water temperature is the biggest problem for fisheries in the Basin. Lack of riparian vegetation that should provide shade and extensive impoundments exposed to the sun behind the numerous dams in the region create challenging conditions for fish populations to thrive. Climate change will continue to add additional thermal stress to these waters.

Full fisheries assessments are available in Appendix B.

Special Values and Features

Waterfalls & Cascades

The Waterfalls, Cascades and Gorges of Vermont (Jenkins & Zika, 1985) highlights seven notable sites in the Basin and numerous others should be highlighted. In the Black River

watershed, Buttermilk Falls on Branch Brook and Cavendish Gorge on the Black River are the best known. Additionally, the recent acquisition of Muckross State Park in Springfield adds Muckross Falls there to those under public ownership. Also in Springfield is Comtu Falls in downtown consisting of a series of falls and cascades over 1,000 feet long. In Reading, Little Niagara Falls and Upper Little Niagara Falls are found on the North Branch of the Black River.

In the Ottauquechee watershed, Quechee Gorge is the largest gorge in Vermont, North Hartland, Quechee Village Falls and Thundering Falls in Killington are all notable.

Two sets of falls are within Ascutney Mountain State Park, Crystal Cascade on Weathersfield's Mill Brook is one of the highest falls in the state and Gerry's Falls is on a tributary to Windsor's Mill Brook, both are accessible from park hiking trails.

Sumner Falls in Hartland on the Connecticut River consist of a set of ledges spanning most of the width of the river. Rapids and low falls of 3-4 feet create whitewater that is popular with advanced paddlers and offers anglers and swimmers access just below the falls. Numerous rare, threatened and endangered plants and animals can be found at the site.

Recreation

Outdoor water-based recreation, swimming, boating and fishing, are important components of living in the region. Recreational resources include public and privately-owned swimming holes and beaches, boat launches on rivers and lakes, and fishing access points and parking. State agencies, municipal departments and local groups are all involved in creating and maintaining these resources.

Swimming holes

Swimming holes are numerous throughout the Basin and well used. Although many areas are used by local residents some sites are distinguished by their long history of use and by their popularity throughout the region.

The Black River hosts Twenty-Foot Hole on the North Branch in Reading, and Buttermilk Falls in Ludlow, on Branch Brook. Also on the Black are Tolles Hill Dam, a USACE recreational area in Perkinsville, and Flat Rock on the Black River opposite Mill Road just north of the Route 106 river crossing in Perkinsville.

The Ottauquechee has popular spots at the Quechee Covered Bridge in Quechee village, the base of the Quechee Gorge, Woodstocker's swimming hole along River Road in Taftsville which has a rope swing and at the Elm Street bridge access downtown. Hartland residents use the sandy beach below the Martins Mill Covered Bridge and Harlow Brook at the Harlow Brook Trailhead culvert crossing under Clay Hill Road.

Along the Connecticut River Wilgus State Park in Ascutney and Sumner Falls, in Hartland, are the best known.

Boating

Kayaks, canoes, powerboats and paddle boards all have their places in Basin 10. Whitewater and flatwater can be enjoyed on rivers, streams, lakes, and ponds. The Connecticut River offers powerboating in the reservoirs behind the hydropower dams which cover most of the river in the region. Sumner Falls is a major whitewater rapid area that is frequently used by kayakers.

Boating regulations on certain waterbodies restrict use or limit the types of crafts that can be used. The **Use of Public Waters Rules** details these waterbodies and restrictions summarized in Table 6.

Table 6. Waterbodies with Use Restrictions

Waterbody	Town	Rules
Amherst Lake	Plymouth	a.
Beaver Pond	Weathersfield	a, b, c, d
Black Pond	Plymouth	a, b, c, d
Colby Pond	Plymouth	a, c, d
Dewey's Mill Pond	Hartford	a, b, c, d
Echo Lake	Plymouth	a
Lake Runnemede/Evart's Pond	Windsor	a, b, c, d
Mill Pond /Kennedy's Pond	Windsor	a, b, d, e
Kent Pond	Killington	a, b
Knapp Brook Ponds #1 & #2	Reading, Cavendish	a, b, d
Lakota Lake	Barnard	a, b, c, d
Lake Ninevah	Mount Holly	a, b, d, f
North Hartland Reservoir	Hartland, Hartford	a
North Springfield Reservoir	Weathersfield, Springfield	a, b, d
Lake Pauline/Reservoir Pond	Ludlow	a, b, d
Lake Pinneo	Hartford	a, b, c, d

Reading Pond	Reading, Plymouth	a, b, c, d
Rescue Lake	Ludlow	a
Stoughton Pond	Weathersfield	a, b, d
Tiny Pond	Ludlow, Mt. Holly	a, b, d
Woodward Reservoir	Plymouth	a, b, d

a. Use of personal watercraft is prohibited
b. Vessels powered by motor shall not exceed 5 mph
c. Use of internal combustion motors is prohibited
d. Use of aircraft is prohibited May 1 - November 30, except where authorized under 5
e. The operation of vessels and vehicles powered by an internal combustion motor except snowmobiles on a designated trail is prohibited
f. Except in an emergency situation or as authorized by the Vermont Transportation Board in accordance with 5 V.S.A. Chapter 9, aircraft are prohibited from landing or taking off

Boating information is available through numerous organizations and web sites including the Connecticut River Paddlers Trail, American Whitewater and the Vermont Outdoor Guide Association.

Table 7. Boating Accesses in the Basin

Waterbody	Town	Amenities
Connecticut River		
• Hoyts Landing	Springfield	Dock, Ramp, Shorefishing Platform
• Sumner Falls	Hartland	Unimproved, car-top, Portage
• Lyman Point Park	White River Junction	Unimproved, car-top
• Blood's Brook	Lebanon, NH	Unimproved, car-top
• Cornish Boat Landing	Cornish, NH	Gravel Ramp
• Wilgus State Park	Ascutney	Unimproved, car-top
• Ashley Ferry State Park	Claremont, NH	Gravel Ramp
• Patch Park	Charleston, NH	Gravel Ramp
• Charlestown Lower Landing	Charleston, NH	Temp. closed for repairs
• Herrick's Cove	Rockingham	Dock, Ramp
Amherst Lake	Plymouth	Ramp
Colby Pond	Plymouth	Gravel Ramp
Echo Lake	Plymouth	Ramp
Kent Pond	Killington	Ramp, Shorefishing Platform
Knapp Ponds #1	Reading, Cavendish	Ramp, Shorefishing Platform

Knapp Ponds #2	Reading, Cavendish	Ramp
Lake Ninevah	Mount Holly	Gravel Ramp
Lake Rescue	Ludlow	Ramp
Woodward Reservoir	Plymouth	Ramp, Shorefishing Platform
Ottauquechee Launch	North Hartland	Unimproved, car-top

Fishing

As mentioned in the Fisheries description on p. 47, fish stocking supplements existing populations on appropriate waters and access points are available throughout the Basin.

Rare, Threatened and Endangered Species and Natural Communities

There are five federally endangered species residing in the Basin. The Dwarf wedgemussel (*Alasmidonta heterodon*) is known to be in the Connecticut River and in the lower reaches of some of the tributaries. The Northeastern or Barbed-bristle Bulrush (*Scirpus ancistrochaetus*), lives in wetlands and beaver ponds. Jesup's Milk-vetch (*Astragalus robbinsii var. jesupii*) clings to steep rocky river outcrops of the Connecticut River. Finally, the Northern Long-eared Bat (*Myotis septentrionalis*) and the Indiana Bat (*Myotis sodalist*) hold out in several mines and caves in the Basin. The Puritan Tiger Beetle (*Cicindela puritan*) is presumed extinct as it has not been seen in over 50 years.

Two other rare species of the Connecticut River are the Cobblestone Tiger Beetle (*Cicindela marginipennis*) and the Alewife Floater (*Anodonta implicate*). Grasshopper Sparrows (*Ammodramus savannarum*), Bald Eagles (*Haliaeetus leucocephalus*) and Rusty Blackbirds (*Euphagus carolinus*) are all known to breed here.

Water Quality Monitoring and Assessment Needs

Water quality monitoring needs to be conducted on the waters listed in Table 8 because they have little or no data. Pertinent data includes macroinvertebrates, fish and water chemistry.

Table 8. Monitoring and Assessment Needs

Black River watershed:
• Knapp Brook – Cavendish
• Alder Meadow Brook – Reading
• Darby Brook – Reading
• Twentymile Stream – Reading, Cavendish
o Whitney Brook – Cavendish, Ludlow
Ottauquechee River watershed:
• North Branch of the Ottauquechee River – upstream sites needed
• Gulf Stream – Woodstock, Pomfret, Barnard
• Tinker Brook – Plymouth, Shrewsbury
• Broad Brook – Bridgewater, Plymouth
o Pinney Hollow Brook – Plymouth
Connecticut River watershed:
• Shepard Brook – Hartland
• McArthur Brook – Hartland
• Bashan Brook – Windsor
• Hubbard Brook – Windsor
o Kimball Brook – Windsor
• Mill Brook - Windsor
• Mill Brook – Weathersfield
• Barkmill Brook – Weathersfield
• Spencer Brook – Springfield
• Gravel Brook – Springfield
Lake assessments are needed on the following lakes for potential reclassification:
• Lakota Lake – Barnard
• Mecawee Pond – Reading
• Woodward Reservoir – Plymouth
• Black Pond – Plymouth
• Tiny Pond – Ludlow, Mount Holly
Wetland assessments are needed conducted on these wetlands for potential reclassification:
• Beaver Pond – Weathersfield
• Killington Flats – Killington, Route 4
• Reading Pond wetlands
• Lake Ninevah wetlands
• Upper Meadows – Rockingham

Chapter 3 – Addressing Stressors, Impaired Waters and TMDLs

Major Stressors

The Vermont Surface Water Management Strategy identifies 10 major stressors that impact surface waters.

Of the ten major stressors and resulting pollutants that can negatively affect the designated uses of Vermont surface waters, four are having the greatest impact across Basin 10. These are channel and land erosion contributing excess sediment and nutrients, encroachments from all forms of development and thermal stress from stormwater runoff and impoundments.

The sub-watersheds of greatest concern due to the cumulative impacts of these stressors are listed as the priority waters for the focused implementation remediation and enhancement projects.

Priority Waters

The following lists those waters which are deemed a priority for remediation. The cause of the pollution is identified after each waterbody.

- Lower Black River – stormwater runoff
- North Branch Black River – erosion, sediment, nutrients, bacteria, lack of buffers
- Lower Ottauquechee River – erosion, sediment, nutrients, bacteria, temperature, development runoff, road issues
- Roaring Brook – stormwater runoff, erosion, sediment
- Kedron Brook –erosion, sediment, nutrients, bacteria, agricultural runoff
- Mill Brook – erosion, sediment, road issues, habitat alteration

Impaired, Stressed and Altered Waters Watershed Summary of Segments with Impacts

Four categories are used in Vermont's surface water assessment data to evaluate individual surface waters in relation to Vermont Water Quality Standards. These are **Full Support**, **Stressed**, **Altered** and **Impaired**. Fully supporting and stressed waters are those that meet the goals of the water quality standards, although stressed waters show some degree of impact from land use activities. Impaired waters do not meet goals of the water quality standards because of one or more particular pollutants. Altered waters do not meet water quality standards because of non-pollutant impacts (e.g., alteration of flow to generate electricity).

Waters deemed to be Impaired, Altered or Stressed are often referred to as "Listed Waters" for their inclusion in the US EPA 303(d) List. Listed waters in the Basin are mapped in Figure 10. Table 9 presents the impacts and stresses on these waterbodies.

Figure 20. Impaired, Stressed and Altered Waters

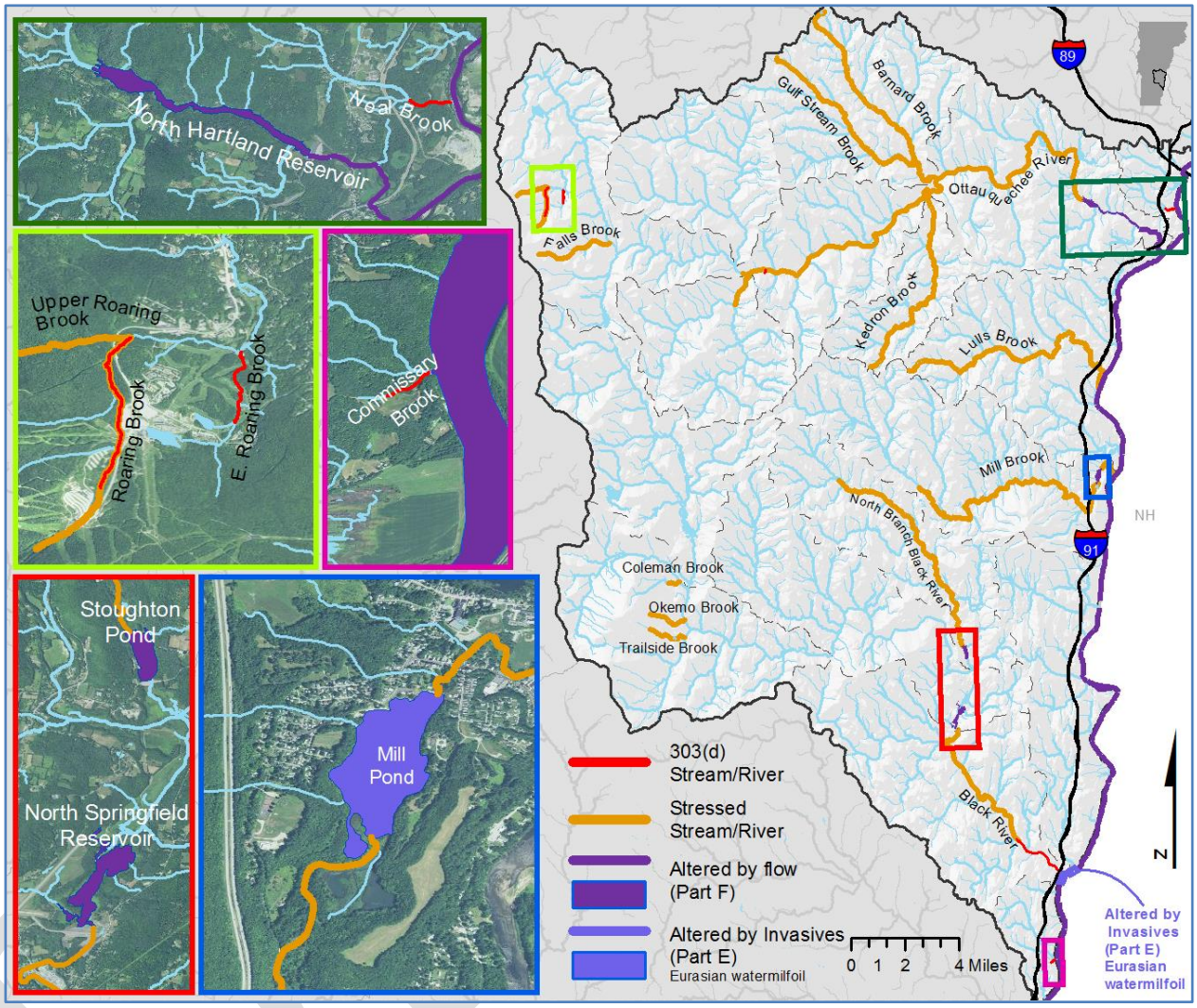


Table 9. Watershed Summary of Segments with Impacts

Waterbody	Miles & Status	Pollutant(s)	Primary Stressor	Use Affected	Problem / Source	Proposed Actions
BLACK RIVER						
Black River - from mouth to Fellows Dam	~4.6 Miles ***Impaired***	*E. coli*		CR	Combined Sewer Overflows	Support continued municipal CSO separation projects; continue implementation of bacteria TMDL for CSO/WWTF-related Bacteria-Impaired Waterbodies
No. Branch Black River	9.3 Miles Above Stoughton Pond ***Stressed***	Sediment, Nutrients, *E. coli*		AES, ALS, CR	Source(s) Need Further Assessment; Notable Erosion	Complete agricultural assessment; implement RAPs; scope, prioritize and implement projects identified in the River Corridor Plan; identify and implement buffer and wetland restoration on high priority sites identified by VDEC
Coleman Brook	~4.6 Mi ***Stressed***	Developed Land Runoff, Changed Hydrology		ALS, AES	Ski Area Development	Develop & Implement a Water Quality Remediation Plan
Okemo Brook	0.1 Miles ***Stressed***	Sand/sediment chlorides		ALS	Elevated Chloride; Chloride Assessment Recommended	Conduct Cl assessment, Develop & Implement a Water Quality Remediation Plan

AES - aesthetics
ALS - aquatic life support
CR - contact recreation
2 CR - secondary contact recreation
RM - river mile

Waterbody	Miles & Status	Pollutant(s)	Primary Stressor	Use Affected	Problem / Source	Proposed Actions
Trailside Brook	Mouth to RM 1.8 *Stressed*	Undefined		ALS	Bugs fail to meet ALS at RM 1.7 (2015 & 2016), and are indeterminate (Fair/Good) at RM 1.8	Develop & Implement a Water Quality Remediation Plan
North Springfield Reservoir	290 acres *Altered*			ALS	Water Level Fluctuation Alters Aquatic Habitat; USACOE Dam; No Conservation Flow based on any Biological/WQ Criteria	Pursue conservation flows through appropriate state regulatory processes
Stoughton Pond	56 acres *Altered*			ALS	Water Level Fluctuation Alters Aquatic Habitat; USACOE Dam; No Conservation Flow Based on Any Biological/WQ Criteria	Pursue conservation flows through appropriate state regulatory processes
OTTAUQUECHEE RIVER						
Small Stream to Ottauquechee River (Bridgewater)	~4.6 Mi *Impaired*	Metals (iron)		ALS, AES	Closed Bridgewater Landfill; Leachate Entering Surface Water	Implement leachate control and remediate wetland impacts
Roaring Brook	RM 3.5 To RM 4.2 *Impaired*	Stormwater		AES, ALS	Stormwater Runoff, Land Development; Erosion	Implement 2011 Water Quality Remediation Plan
East Branch Roaring Brook	RM 0.1 To RM 0.6 *Impaired*	Stormwater, Iron		AES, ALS	Stormwater Runoff, Land Development, Erosion	Remediate iron impairment by implementing 2011 Water Quality Remediation Plan

Waterbody	Miles & Status	Pollutant(s)	Primary Stressor	Use Affected	Problem / Source	Proposed Actions
Lower Ottauquechee River, Below North Hartland Dam	0.9 Mile ***Altered***			AES, ALS, 2CR	Artificial Flow Regulation & Condition; Flow Regulation Largely Controlled by Hydro Facility. FERC License Expires In 2021	Pursue conservation flows through appropriate state regulatory processes
Lower Ottauquechee River, Below Woolen Mill Dam	0.1 Mile ***Altered***			AES	Artificial Flow Condition, Dewatering of Falls By Hydro	Pursue conservation flows through appropriate state regulatory processes
North Hartland Reservoir	215 acres ***Altered***			ALS, 2CR	Annual Water Level Fluctuations Alter Aquatic Habitat; Dam Now Used for Hydropower; Operated Under FERC License Expiring In 2021	Pursue conservation flows through appropriate state regulatory processes
Ottauquechee River	9.5 Miles Kedron Brook down to No. Hartland Res ***Stressed***	Nutrients, Organic Enrichment, Temperature, Sediment, *E. Coli*		ALS, CR, 2CR, AES	Golf Course, Road, Developed Land Runoff, Septic Systems, Fertilized Turf, Bugs Borderline.	Scope and implement priority projects identified in the River Corridor Plan
Ottauquechee River	10.0 Miles Bridgewater Corners down to Woodstock ***Stressed***	Sediment, Physical Alteration, Temperature		ALS, AES, 2CR	Channelization (Pre- and Post-Irene), Road Encroachment and Runoff, Wide Channel	Scope and implement priority projects identified in the River Corridor Plan

Waterbody	Miles & Status	Pollutant(s)	Primary Stressor	Use Affected	Problem / Source	Proposed Actions
Falls Brook Tributary #4	0.4 Miles *Stressed*	Sediment		ALS	Land Development; Erosion; Streambank Destabilization	Develop & implement a Water Quality Remediation Plan
Upper Roaring Brook and West Branch	Approx. 1.2 Miles *Stressed*	Sediment		AES, ALS	Land Development; Erosion; Road Runoff	Develop & implement a Water Quality Remediation Plan
Kedron Brook - Woodstock	6.0 Miles *Stressed*	Sediment, Nutrients, *E. coli*		AES, ALS, CR	Horse Recreation Activity; Pasture; Road Runoff; Loss of Riparian Vegetation; Golf Course	Complete agricultural assessment; implement RAPs; scope, prioritize and implement projects identified in the River Corridor Plan; identify and implement buffer and wetland restoration on high priority sites identified by VDEC
Broad Brook	1.5 Miles *Stressed*	Sediment, Physical Alterations		ALS, AES	Streambank Erosion, Channelization, Gold Dredging (In Past At Least)	Identify target areas for river corridor protection and restoration and work with landowners to secure easements
Barnard Brook	2.0 Miles *Stressed*	Sediment, Temperature		ALS	Source(s) Need Further Assessment	Identify target areas for river corridor protection and restoration and work with landowners to secure easements

Gulf Stream Brook	4.2 Miles ***Stressed***	Sediment		2CR	Gravel Road Maintenance	Complete Road Erosion Inventory and implement priority projects

Waterbody	Mileage & Status	Pollutant(s)	Primary Stressor	Use Affected	Problem / Source	Proposed Actions
CONNECTICUT RIVER						
Neal Brook	Mouth to RM 0.4 ***Impaired***	Metals		ALS	Macroinvertebrates Impacted by Landfill Drainage	Implement leachate control and remediate stream impacts
Commissary Brook Tributary	Mouth to RM 0.2 ***Impaired***	Sediment		AES, ALS	Bank Failure and Erosion Due to Past Clay Mining	Address mass failure
Mill Pond (Kennedys Pond) (Windsor)	14 acres ***Altered***			AES, ALS, CR, 2CR	Locally abundant Eurasian Watermilfoil growth	Develop and implement an invasive species management plan
Connecticut River	Hoyts Landing & Wilder Dam TransCanada Launches ***Altered***			AES, ALS, CR, 2CR	Locally abundant Eurasian Watermilfoil growth	Develop and implement an invasive species management plan
Connecticut River	20.5 Miles Wilder Dam to Ascutney Village ***Altered***			ALS	Artificial Flow Condition, Fluctuating Flows Associated with Hydropower Production; FERC License Expires In 2018	Currently under review for FERC re-licensing; pursue conservation flows through appropriate state regulatory processes

Waterbody	Miles & Status	Pollutant(s)	Primary Stressor	Use Affected	Problem / Source	Proposed Actions
Connecticut River	21.5 Miles Above Bellows Falls Dam ***Altered***			ALS	Water Level Fluctuation at Dam; Dewatered Shorelines/Wetlands; FERC License Expires In 2018	Currently under review for FERC re-licensing; pursue conservation flows through appropriate state regulatory processes
Connecticut River	Above Bellows Falls Dam to Springfield ***Altered***			AES, ALS	Reservoir Water Level Fluctuation at Dam; Destabilized Eroding Streambanks; Observed Impacts to Skitchewaug Archeological Site; Site Rip-Rapped; FERC License Expires In 2018	Currently under review for FERC re-licensing; pursue conservation flows through appropriate state regulatory processes
Lulls Brook	8.0 Miles ***Stressed***	Sediment		AES, ALS	Sedimentation from Gravel Road Runoff & Other Sources; Needs Additional Assessment	Complete Road Erosion Inventory and implement priority projects
Mill Brook	1.0 Miles Mill Pond Dam to Conn Rv ***Stressed***	Sedimentation, Stormwater		ALS, AES	Impoundment De-Silting, Developed Land Runoff	Scope and implement priority projects identified in the River Corridor Plan
Mill Brook	8.6 Miles Willow Brook confluence to Mill Pond ***Stressed***	Sediment, Habitat Alteration		ALS	Streambank Erosion, Road Maintenance & Runoff; Biological community not meeting expectations.	Scope and implement priority projects identified in the River Corridor Plan; complete Road Erosion Inventory and implement priority projects

Total Maximum Daily Loads

A TMDL or Total Maximum Daily Load is the calculated maximum amount of a pollutant that a waterbody can receive and still meet Vermont Water Quality Standards. In a broader sense, a TMDL is a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards and develops a means to implement those reductions. TMDLs can be calculated for reducing water pollution from specific point source discharges or for an entire watershed to determine the location and amount of needed pollution reductions.

Under Section 303(d) of the Federal Clean Water Act, all states are required to develop lists of impaired waters. The list includes impaired lakes, ponds, rivers and streams that do not meet Water Quality Standards. For Vermont, impairment is substantiated by chemical, physical or biological data collected through monitoring and these waters are noted on the state's 303(d) list of Impaired Waters. The Federal Clean Water Act requires TMDLs to be developed for waters on the list; the list provides a schedule indicative of TMDL completion priority.

Waters with a completed TMDL or a TMDL equivalent are listed in 2016 Priority Listing of Vermont Waters

TMDLs for Basins 10 include:

- Black River - Ludlow - phosphorus
- Vermont Statewide Total Maximum Daily Load (TMDL) for Bacteria-Impaired Waters
    - Appendix 19- CSO & WWTF Related (Springfield)[5]
- Long Island Sound (LIS) Dissolved Oxygen TMDL
- Northeast Regional Mercury Total Maximum Daily Load

The Long Island Sound Dissolved Oxygen TMDL released in 2000 is designed to address low dissolved oxygen or hypoxia in Long Island Sound bottom waters. It is often referred to as the Connecticut River Nitrogen TMDL because it is linked to an overabundance of nitrogen discharging into the Sound from the Connecticut River and other tributaries. While nitrogen is essential to a productive ecosystem, too much nitrogen fuels the excessive growth of algae. When the algae die, they sink to the bottom, where they are consumed by bacteria. The microbial decay of algae and the respiration of oxygen-breathing organisms use up the

[5] These waters are impaired for *E.coli* due to the influence of wastewater treatment facilities and combined sewer overflows. These waters are not covered under this TMDL but specifics regarding their location and management status is included in this document for informational purposes only.

available oxygen in the lower water column and in the bottom sediments, gradually reducing the dissolved oxygen concentration to unhealthy levels.[6]

In 2013 a Vermont-specific section was added to the LIS-TMDL to address four goals. First, to identify the Vermont sources of nitrogen as they are currently understood, across broad land use sectors, such as developed, agricultural and forested;

Second, to identify the current status and trends of important drivers of nitrogen export such as the intensity of agricultural and development activities and investigate how these might have changed since the TMDL baseline time period of 1990;

Third, to identify the management programs that address these drivers of nitrogen loading that have a significant effect on reducing or preventing nitrogen export. A part of this is to identify a timeline as to when programs were initiated or enhanced; and

Fourth, using a weight-of-evidence approach, to assess the combined management programs/projects to develop a qualitative evaluation as to whether management efforts are sufficient to meet the original 2000 TMDL of a 10% NPS nitrogen reduction and if these actions are sufficient to maintain that control into the future. [7]

Vermont nitrogen export to LIS is estimated to be about 4% of the total load to the Sound. Modeling estimates the breakdown of nitrogen sources in Vermont. Approximately 21% of Vermont's nitrogen export originates from agricultural areas and approximately 4% originates from developed areas. Of note is that approximately 65% of the nitrogen exported from Vermont originates as atmospheric deposition.[8]

In 2017, EPA embarked on its Nitrogen Reduction Strategy to investigate and better define control actions to reduce nitrogen in the Long Island Sound. A summary from EPA's Long Island Sound Study website is given below:

> EPA is implementing a strategy to aggressively continue progress on nitrogen reductions, in parallel with the States' continued implementation of the 2000 Total Maximum Daily Load (TMDL), and achieve water quality standards throughout Long

[6] A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound
[7] Vermont Enhanced Implementation Plan for the Long Island Sound TMDL
[8] Ibid

Island Sound and its embayments and near shore coastal waters. The strategy recognizes that more work must be done to reduce nitrogen levels, further improve dissolved oxygen (DO) conditions, and address other nutrient-related impacts in Long Island Sound. The nitrogen reduction strategy complements the 2000 TMDL in important ways. Foremost, while the 2000 TMDL is premised on achieving water quality standards for DO in the open waters of LIS, the EPA strategy expands the focus to include other nutrient-related adverse impacts to water quality, such as loss of eelgrass, that affect many of LIS's embayments and near shore coastal waters.

The sources of nitrogen to be addressed in Vermont include wastewater discharges, agricultural lands, developed lands and forest practices. Overarching strategies include:

- Continue implementation of nitrogen reductions from wastewater treatment plants (WWTPs), including capping WWTP nitrogen loads, monitoring nitrogen discharged from WWTPs, and the completion of nitrogen removal optimization studies at WWTFs in the VT portion of the LIS watershed.
- Control non-point source discharges from agricultural lands through implementation of RAPs and BMPs to decrease sediment and nutrient runoff.
- Continue implementation of state stormwater permits covering construction, roads, direct and indirect discharges.
- Decrease discharges from forestry practices through continued implementation of AMPs, outreach and the use of portable skidder bridges.

The Long Island Sound Watershed Regional Conservation Partnership Program (LISW-RCPP) was created in 2015 across six states to coordinate the development and implementation of a comprehensive working lands program with foci on: 1) nutrient management and soil health, 2) protection of non-industrial forest habitat, biodiversity, and drinking water sources, and 3) stem erosion and improve resiliency on working lands through riparian restoration.
In partnership with the Vermont Association of Conservation Districts (VACD), UVM Extension, the Connecticut River Conservancy, The Nature Conservancy and federal, state and local organizations in NH, MA, CT, NY and RI ten million dollars is being invested in the adoption of best management practices on private working lands, providing both technical and financial assistance.[9]

[9] LISW-RCPP website at: http://www.lisw-rcpp.com/home.html

TMDL Implementation Update

As waters are remediated, they are removed from the TMDL list. As new impairments occur or are documented, new TMDL's are drafted. Work is ongoing on several sites to remediate the impairments that the TMDLs regulate. Both Springfield and Ludlow have implemented projects to address the pollutants from their respective wastewater discharges.

Black River, from mouth to 2.5 mi. upstream - Springfield
Springfield WWTF Combined Sewer Overflows
Progress Toward CSO Elimination: Originally there were approximately 25 combined sewer overflows in the Springfield WWTF collection system. Upon completion of the work currently underway in 2017, all CSOs will be disconnected from the stormwater system.

Waters Removed from 303(d) List
As waters are improved by positive work in the watershed and they come back into compliance with the VWQS they are removed from the impaired waters list. There has been one recent successful de-listing of an impaired stream in Basin 10.
Black River, below Ludlow WWTF for approx. 0.5 Miles – Ludlow
Improvements at the Ludlow Wastewater Treatment plant have resulted in a decrease in phosphorus discharge into the river. Phosphorus loads are now within acceptable limits and this reach of the river is no longer listed as impaired.

Known Contaminants & Direct Discharges

The Sites Management Section (SMS) of VDEC provides State oversight of the investigation and cleanup of properties where a release of a hazardous material has contaminated the environment, including soils, groundwater and surface water. The Vermont Hazardous Waste Management Program (HWMP) regulates the generation, transportation, storage, treatment, recycling and disposal of hazardous waste, used oil, and universal hazardous waste. All known permitted and unpermitted hazardous waste sites and generator facilities are tracked.

Locations of these sites along rivers and streams make them vulnerable to erosion which could lead to contamination of adjacent waters. These sites should be carefully tracked and monitored for soil erosion and bank stability. Site locations of these sites are shown in Figures 10 – 12.

Of particular concern are the brownfields sites indicted on Figures 11 and 12.

Figure 21.

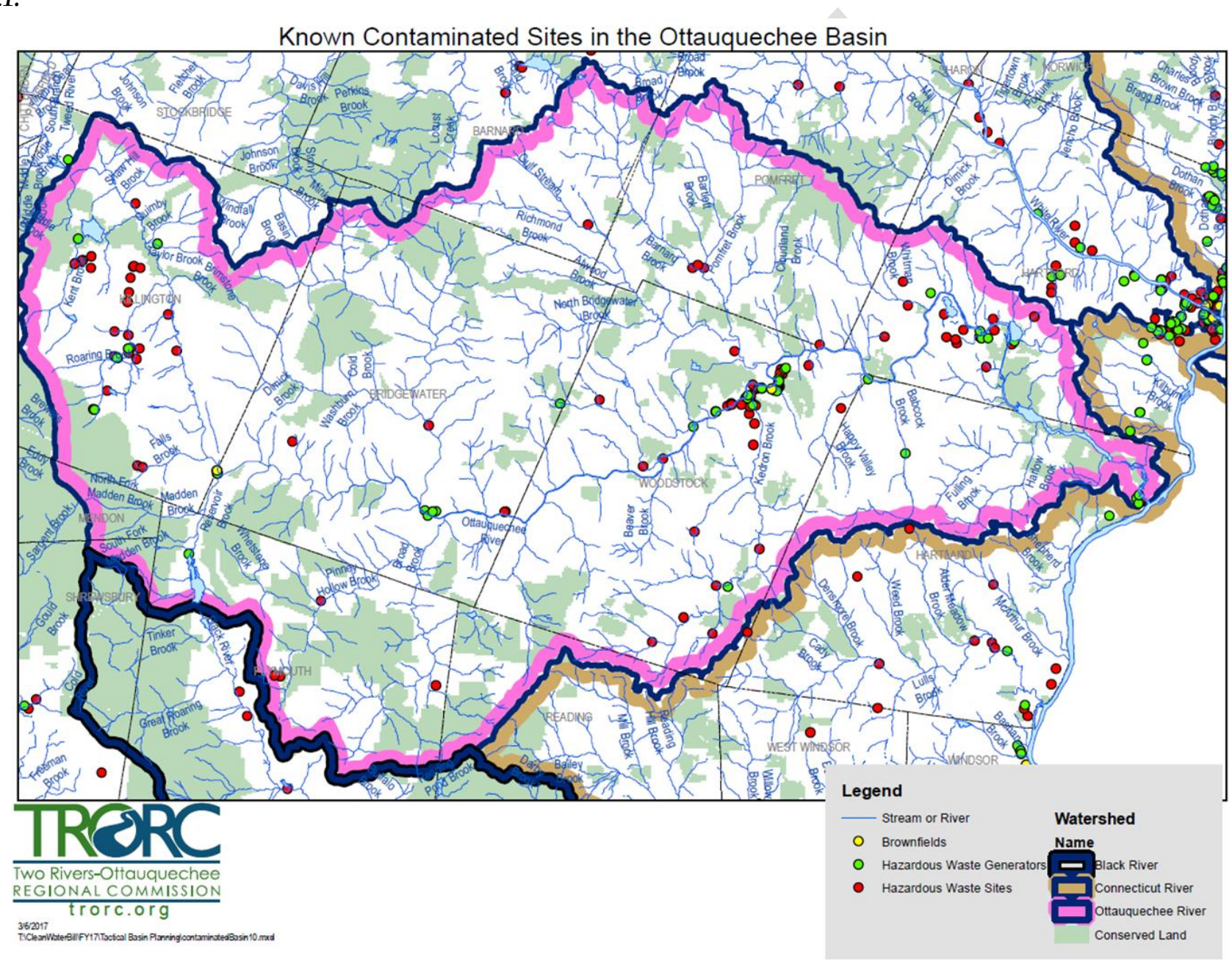

Known Contaminated Sites in the Ottauquechee Basin
Legend
Stream or River
Brownfields
Hazardous Waste Generators
Hazardous Waste Sites
Watershed
Name
Black River
Connecticut River
Ottauquechee River
Conserved Land
Two Rivers-Ottauquechee
REGIONAL COMMISSION
trorc.org
3/6/2017
T:\CleanWaterBill\FY17\Tactical Basin Planning\contaminatedBasin10.mxd

Figure 22.

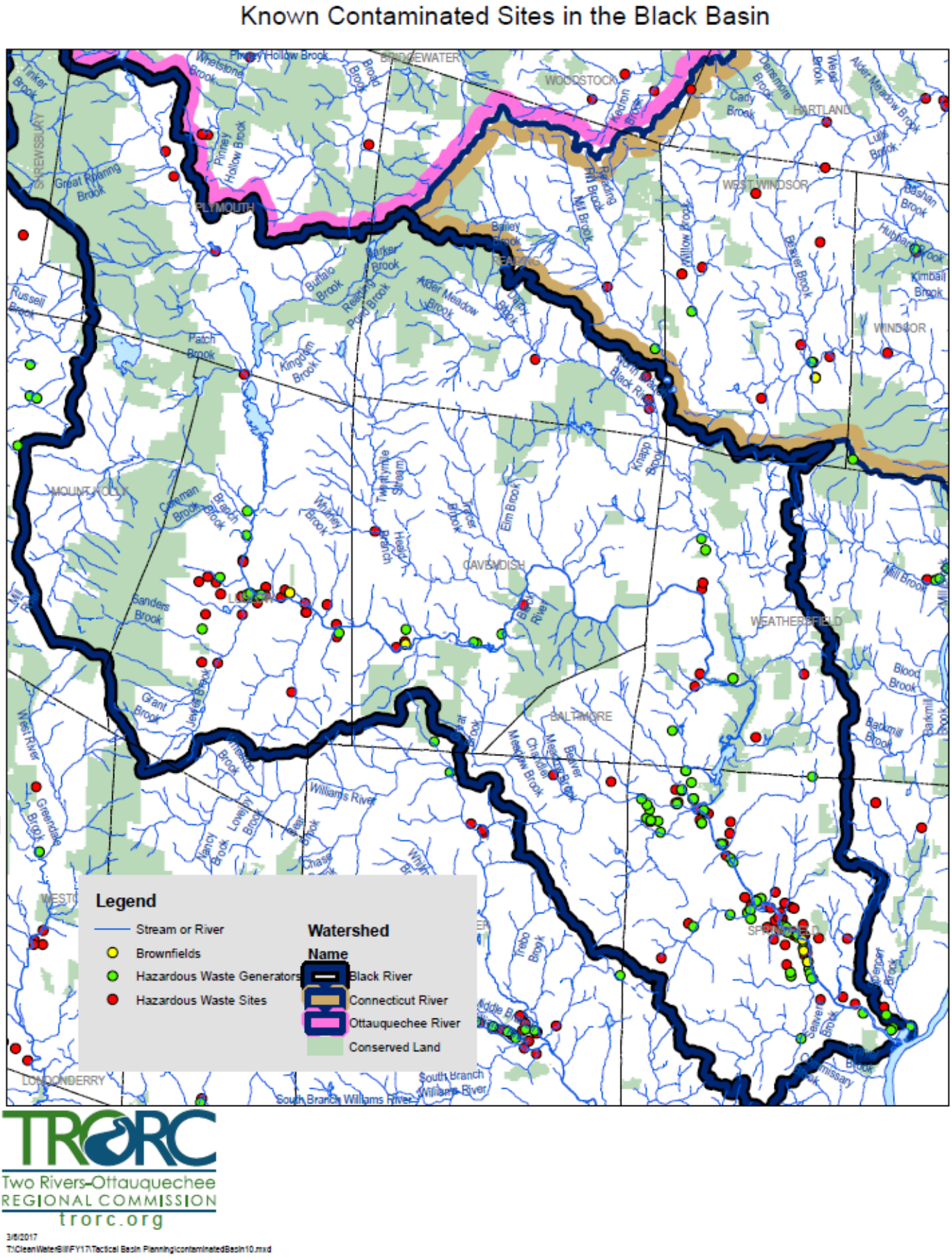
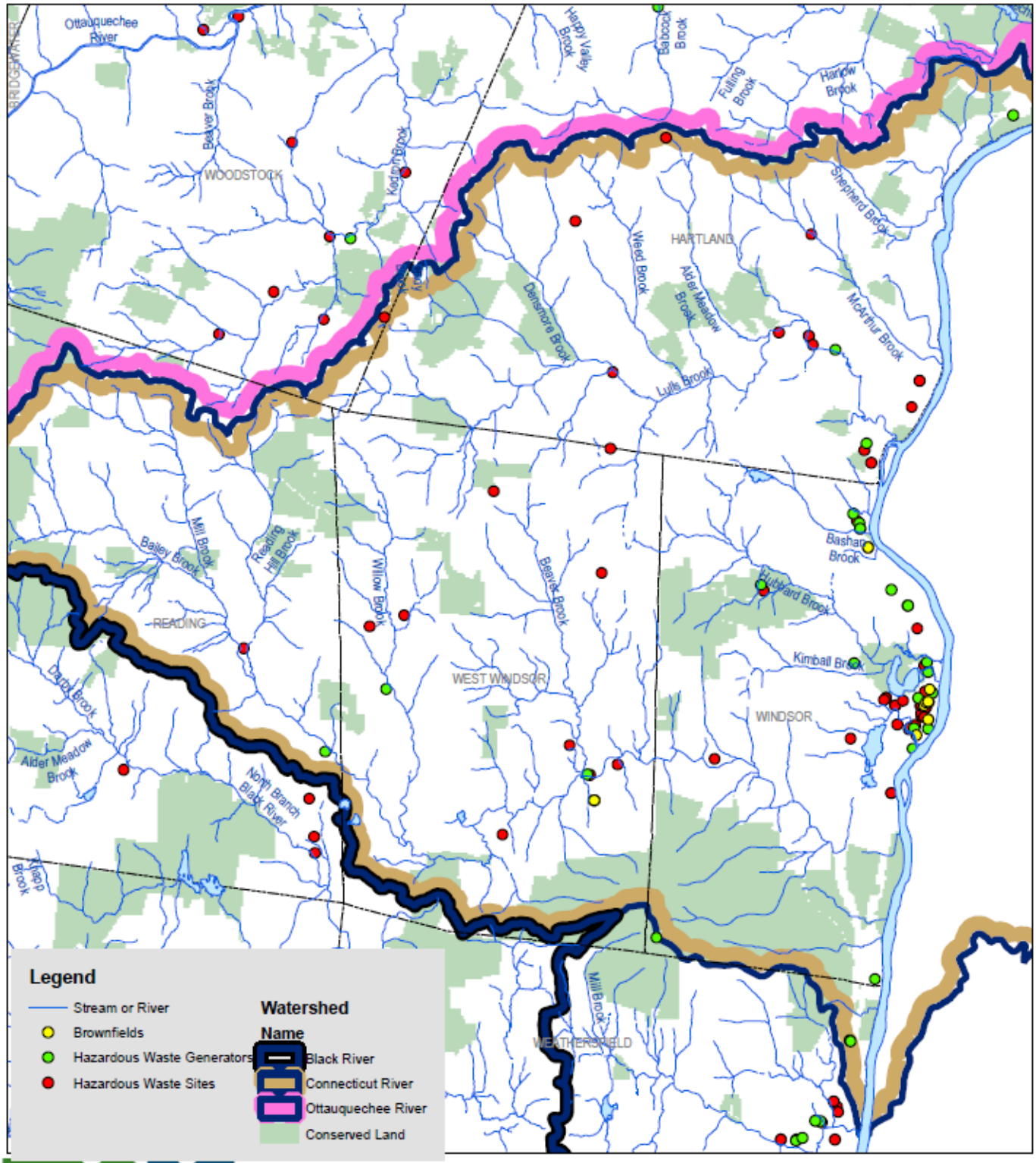

Known Contaminated Sites in the Black Basin
Legend
Stream or River
Brownfields
Hazardous Waste Generators
Hazardous Waste Sites
Watershed Name
Black River
Connecticut River
Ottauquechee River
Conserved Land
Two Rivers-Ottauquechee
REGIONAL COMMISSION
trorc.org
3/8/2017
T:\CleanWater\GIS\FY17\Tactical Basin Planning\contaminatedBasin10.mxd

Figure 23.

Known Contaminated Sites in the Connecticut River Tributaries



Two Rivers-Ottauquechee REGIONAL COMMISSION
trorc.org

3/6/2017
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Direct Discharges

The Wastewater Management Program provides regulatory oversight for and technical assistance to Vermont's wastewater treatment facilities in cooperation with State, regional and national organizations. All municipal, industrial and commercial facilities that discharge wastewater directly from a point source (such as a pipe, ditch or channel) into a receiving waterbody (lake, river, or ocean) are required to have a National Pollutant Discharge Elimination System (NPDES) permit issued by the State of Vermont.

Facilities that discharge to a wastewater treatment facility, which in turn discharges into the receiving waterbody, are not subject to NPDES permits; rather they are controlled by the national pretreatment program. The State of Vermont has been given authority by the NPDES program from the federal government to issues permits through the Wastewater Management Program.

Of the 18 NPDES permits in the Basin, twelve cover discharges from wastewater treatment facilities (WWTF). Four are mine-related, one medical and one hydropower.

Controlling Phosphorus from Wastewater Treatment Facilities and Other Industrial Discharges

An overarching consideration for the issuance of permits in the Ottauquechee/Black planning basin is the Long Island Sound TMDL for nitrogen. This multi-state TMDL has been promulgated with interim wasteload and nonpoint source nitrogen load allocations. As of the issuance of this Plan, all facilities are operating under permits developed under a nitrogen permitting strategy whereby all Vermont WWTFs ultimately discharging to the Connecticut River must, collectively, discharge no more than 1,727 lbs of Total Nitrogen (TN)/day. Each individual facility has a unique TN loading limit. In addition to the nitrogen loading limit, WWTFs are required to develop optimization plans for maximizing nitrogen removal and regularly monitor for nitrogen compounds.

The municipal wastewater discharge permits in place in the Basin are shown in Table 10. As part of a necessary refinement of the facility-specific nitrogen limits, the WSMD, with assistance from certain municipalities, is conducting an extensive sampling effort. This effort will document the current loading conditions and determine the "reasonable potential" that WWTFs have to cause or contribute to downstream water quality impairment.

Table 10. Summary of Permit Requirements for Wastewater Treatment Facilities

Facility (permit ID)	Permit expiration date	Design flow MGD	IWC* 7Q10 /LMM	Current Percent of Design Flow (YEAR)	Treatment type	Number of non-compliant CSOs	Receiving water
Bellows Falls (3-1297)	9/30/2021	1.400	0.002/ 0.001	27% 4/16 – 4/17	Rotating Biological Contactors	0	Connecticut River
Bridgewater (3-1156)	9/30/2021	0.043	0.007/ 0.002	17% (4/16-4/17)	Rotating Biological Contactors	0	Ottauquechee River
Cavendish (3-1205)	9/30/2019	0.150	0.020/ 0.007	43% (6/16-6/17)	Aerated lagoons	0	Black River
Hartford – Quechee (3-1185)	3/31/2019	0.475	0.016/ 0.006	44% (4/16-4/17)	Sequential Batch Reactors	0	Ottauquechee River
Ludlow (3-1208)	12/31/2019	1.050	0.155/ 0.058	34% (4/16-4/17)	Extended aeration	0	Black River
Sherburne FD#1 (3-1243)	3/31/2020	0.300	0.141/ 0.043	25.3% (7/16 – 6/17	Rotating Biological Contactors	0	Ottauquechee River
Springfield (3-1154)	9/30/2020	2.200	0.149/ 0.059	39% (2/16-2/17)	Activated Sludge	13 (will be 2 at end of current abatement project)	Black River
Windsor - Main (3-1253)	9/30/2021	1.130	0.002/ 0.001	22% (4/16-4/17)	Rotating Biological Contactors	0	Connecticut River
Windsor Weston Heights (3-1168)	12/31/2021	0.015	<0.001/ <0.001	35% (6/16-6/17)	Extended aeration	0	Connecticut River
Woodstock – Main (3-1228)	3/31/2020	0.450	0.032/ 0.011	48% (6/16-6/17)	Extended aeration	0	Ottauquechee River
Woodstock – South (3-1178)	9/30/2021	0.050	0.099/ 0.029	17% (4/16-4/17)	Extended aeration	0	Kedron Brook
Woodstock – Taftsville (3-1179)	12/31/18	0.010	0.001/ <0.001	27% (4/16-4/17)	Activated Sludge	0	Ottauquechee River

** Instream Waste Concentration – or the proportion of river flow at lowest base (7Q10) and low median monthly (LMM) flow attributable to discharge, for the facility design flow. Note that the IWC is specific to the flow of receiving water.*

MGD – million gallons per day

Facility-specific information

Bridgewater

The Town of Bridgewater operates a Rotating Biological Contactor (RBC) facility which was constructed in 1978. Raw wastewater enters equalization tanks for primary settling before entering an RBC unit, followed by secondary clarification and chlorine disinfection and dichlorination. The clarifier returns the sludge to a sludge holding tank.

Cavendish

The Town of Cavendish operates a secondary treatment facility consisting of three aerated lagoons for treatment and chlorine disinfection and dichlorination.

Hartford-Quechee

The Town of Hartford operates a Sequencing Batch Reactors (SBR) facility (upgraded from a lagoon system in 2010) for secondary treatment with Ultra Violet disinfection which precludes the use of chlorine.

Ludlow

The treatment system is an oxidation ditch followed by clarification and alum addition for phosphorus removal. Disinfection is achieved by chlorination followed by dechlorination prior to discharge to the Black River.

Sherburne FD#1

This wastewater treatment facility consists of RBCs with chlorination/dechlorination for disinfection. Several components were replaced or upgraded in 2012 including influent pump, clarifier troughs, the RBC outlet and chlorine tank. The population serviced by this facility fluctuates seasonally with highest flows occurring in the winter.

Springfield

The Town of Springfield operates this facility which is an activated sludge treatment system. The facility was upgraded in 2005, and consists of two primary clarifiers, four biological reactors and two secondary clarifiers. The flow from the secondary clarifiers is disinfected with UV and discharged to the Black River, a tributary of the Connecticut River. It's anticipated that the permitted flow will increase to 2.4 MGD when an ongoing CSO abatement project is completed, potentially in Fall 2017.

Windsor-Main

The Town of Windsor owns and operates the Windsor Main Wastewater Treatment Facility. The facility consists of two primary clarifiers, twelve RBCs, two secondary clarifiers, and a

chlorine contact tank for disinfection and dichlorination. A centrifuge is used to dewater the sludge.

The Ascutney Mountain Sewer System consists of two pump stations and a force main that pumps sewage from the resort and surrounding area to the Town of Windsor collection system. The Ascutney System property transferred ownership in February 2014; Pump Station #1 is located in and owned by the Town of West Windsor and Pump Station #2 is located in and owned by the Town of Windsor.

Windsor Weston Heights

The Weston Heights development owns and operates the Weston Heights Wastewater Treatment Facility which is an extended aeration "package plant". The facility was constructed in 1972 and began operation in January 1973. Several upgrades were made in the early 2000's following recommendations in a 1998 engineering evaluation. These included improvements to the influent pump station, construction of a new control building, new RAS/WAS pumps, and the installation of a second final clarifier. The facility discharges secondary treated and chlorinated/dechlorinated wastewater to the Connecticut River.

Woodstock-Main

The Town of Woodstock operates this facility which consists of two aeration basins and two secondary clarifiers followed by chlorine disinfection and dichlorination. The Town has actively pursued elimination of CSOs – two of the original three have been plugged and the third's unauthorized discharge has been eliminated due to control of infiltration and inflow.

Woodstock-South

The Town of Woodstock owns and operates the South Woodstock Wastewater Treatment Facility, a small extended aeration package plant with chlorination for disinfection and dichlorination before being discharged to Kedron Brook. The facility was constructed in 1966.

Woodstock-Taftsville

The Town of Woodstock operates this facility which is an extended aeration activated sludge secondary "package plant". Chlorination/ dichlorination is used for disinfection.

Flood Resiliency

Precipitation trend analysis indicates that the state of Vermont and the Basin 10 watersheds will receive increased rainfall in the future, primarily in the form of intense, local storms that drop high volumes of rainfall in short durations. Due to the surrounding terrain, the mainstems of the Ottauquechee and Black Rivers are especially vulnerable to flooding, which

occurs when the rivers receive more water from precipitation and/or snowmelt than they typically experience. As a result, waters fill the channels of rivers, overflow their banks, and inundate floodplain areas that normally do not have water. Fluvial erosion also occurs during flooding events, as well as during natural hydrologic function, as water that passes through stream channels and exerts energy upon its streambanks.

The topography of Basin 10, consisting of steep slopes and narrow river valleys, make it especially vulnerable to flooding and erosion. Much of the watershed consists of steep slopes and narrow valleys, and features many small, mountainous streams that parallel transportation infrastructure. These smaller streams are flashier in nature, and are vulnerable to flooding and severe erosion that can occur during storm events.

Tropical Storm Irene, which cascaded across the region in late August of 2011, caused widespread and severe damage to the Towns that compose Basin 10. Altogether, these communities experienced $24,637,766 in damages. The Towns in the Ottauquechee River watershed experienced $12,686,382 in damages and the Towns in the Black River watershed experienced $12,535,826 in damages.

Efforts to increase the resiliency of the watershed and its communities to future flooding events are ongoing. Communities and individuals worked extremely hard in the months and years following Tropical Storm Irene to strengthen areas of vulnerability and to implement projects to mitigate future damage to health and property as a result of flooding. However, much work remains in order to protect communities as future flooding and intense rain events continue will likely persist.

In 2011, Act 110 established a river corridor management program and a shoreland management program. Act 138 followed in 2012 expanding the state's regulatory and technical assistance programs with respect to the management of rivers, river corridors, and floodplains. Financial incentives for municipalities have been established in accordance with to the requirements of 10 V.S.A. §§ 1425 and 1427 for the adoption and implementation of municipal zoning bylaws that protect and preserve river corridors, shorelands and buffers.

Communities become eligible for financial incentives for river corridor and floodplain protection based on a rating system that considers a suite of mitigation activities, including implementation of Standard River Management Practices. Emergency Relief and Assistance (ERAF) rules now recognize towns that have increased river corridor and floodplain protection and provide an increased state cost share for emergency relief funding.

Four towns in Basin 10 have completed this process and will receive the maximum 17.5% State match for future damages these are Baltimore, Barnard, Plymouth and Shrewsbury. Twelve towns have reached the 12.5% match rate and six towns remain at the 7.5% rate. An updated list can be found at ERAF Summary Sheet[10].

The Vermont Legislature passed Act 16, which took effect in July 2014. The Act requires municipal and regional plans to incorporate a "flood resilience" component into all future plans. Working towards resiliency means both proactively reducing vulnerabilities to flooding and flood damage, and improving response and recovery efforts when flood events do occur, so that communities bounce back quickly and minimize long term economic, social, and natural resource impacts. The effort has led to the creation of maps[11] to identify local flood hazard areas, identifying specific areas that should be protected for their values of slowing down or attenuating floodwaters (including floodplains, river corridors, forests and wetlands) and recommending specific strategies and policies that will help protect these areas and reduce the risks facing existing development. ANR is providing resources and assistance to make flood resiliency an integral part of town planning including river corridor maps and model language for town plans. Numerous Tactical Basin Plan actions will assist communities in becoming more flood resilient.

The Emergency Relief and Assistance Fund provides State funding to match Federal Public Assistance after federally-declared disasters[12]. Eligible public costs are reimbursed by federal taxpayers at 75%. For disasters after 2014, the State of Vermont will contribute an additional 7.5% toward the costs leaving the municipal share of 17.5%. For communities that take specific steps to reduce flood damage the State's contribution will increase to 12.5% or 17.5% of the total cost.

The four mitigation measures towns must have in place to receive 12.5%:

1. National Flood Insurance Program (participate in or have applied to);
2. Town Road and Bridge Standards – (annually certify adopted standards that meet or exceed the standards in the most current: VTrans Orange Book: Handbook for Local Officials);
3. Local Emergency Operations Plan (adopted annually after town meeting);

[10] http://floodready.vermont.gov/assessment/community_reports
[11] tinyurl.com/floodreadyatlas
[12] https://www.fema.gov/disasters/grid/state-tribal-government/35?field_disaster_type_term_tid_1=All

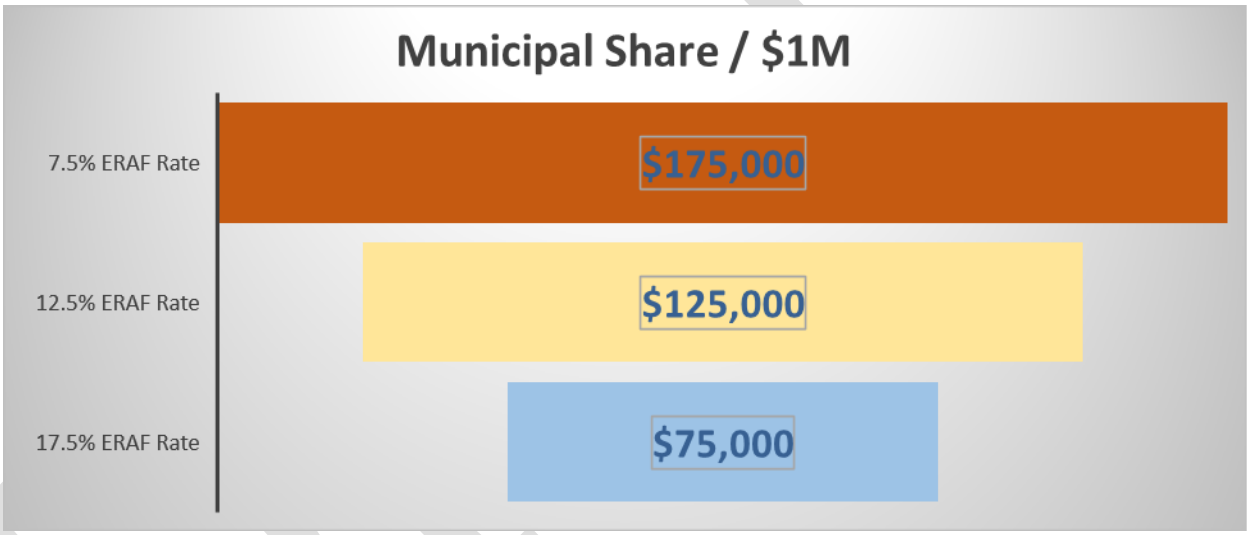
4. Local Hazard Mitigation Plan - adopt a FEMA- approved local plan (valid for five years).

To receive 17.5% - eligible communities also must:

5. Protect River Corridors from new encroachment; or, protect their flood hazard areas from new encroachments and participate in the FEMA Community Rating System.

After a declared disaster, the damage to public infrastructure including roads and culverts can exceed a million dollars. Adoption of these resiliency measures can mean significant savings for municipal taxpayers. As Figure 14. demonstrates, in the event of $1,000,000 in damages to infrastructure, the municipal share of recovery costs will decrease by up to $100,000 when ERAF protections are in place.

Figure 24. Emergency Relief and Assistance Fund Cost Share



From: http://floodready.vermont.gov/find_funding/emergency_relief_assistance

Another resiliency effort undertaken is the Vermont Economic Resiliency Initiative (VERI). With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, VERI was launched to help ensure Vermont remains open for business when disaster strikes.

VERI assisted the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy. The Town of Woodstock was selected for a more detailed analysis of the local

flood risks to the community and businesses. This Community Report[13] provides the foundation for the team to develop community-tailored action plans to reduce the loss of jobs, inventory, revenue, as well as the cost to repair roads, bridges and other key infrastructure.

[13] http://accd.vermont.gov/sites/accdnew/files/documents/CD/CPR/CPR-VERI-Woodstock-CommunityReport.pdf

Chapter 4 – Management Goals for Protecting Surface Waters

The protection or improvement of water quality and water-related uses can be promoted by establishing specific management goals for individual bodies or stretches of water. The management goals describe the values and uses of the surface water that are to be protected or achieved through appropriate management. In Chapter 2 of this plan, a number of waters were identified as being of notable high quality, and these, as well as other unique areas, may be candidates for establishing alternate management goals or augmented protections through one of the processes that are further described below.

- Identification of existing uses
- Designation of Outstanding Resource Waters
- Reclassification of waters
- Reclassification of wetlands
- Designation of waters as warm-water or cold-water fisheries

The Agency of Natural Resources is responsible for determining the presence of existing uses on a case by case basis or through basin planning, and is also responsible for classification or other designations. Once the Agency establishes a management goal, the Agency manages state lands and issues permits to achieve all management goals established for the associated surface water. Before the Agency recommends management goals through a classification or designation action, input from the public on any proposal is required and considered. The public may present a proposal for establishing management goals for Agency consideration at any time. When the public advances proposals regarding management goals, the increased community awareness can lead to protection of uses and values by municipalities and individuals.

Public involvement is an essential component to restoring and protecting river and lake ecology. The Vermont Water Quality Standards state "Public participation shall be sought to identify and inventory problems, solutions, high quality waters, existing uses and significant resources of high public interest." Emphasis on the identification of values and expectations for future water quality conditions can only be achieved through public contributions to the planning process.

Changes in the 2017 Vermont Water Quality Standards created a new class for waters. The previous classes were A(1), A(2) and B. The new classification includes A(1), A(2) and B(1) and B(2). The new class of B(1) and B(2) allow for increased protection of waters that meet very high water quality standards but do not rise to Class A status. Water classification is now based on the separate and specific uses of the waterbody which include aquatic biota and

wildlife, aquatic habitat, aesthetics, fishing, boating, swimming, irrigation and public water supply. Class A(2) is reserved for active public water supply waters.

A water may be classified with a mix of designations based on its uses. For example a river that is heavily used for fishing but has dams that block boating access may be B(1) for fishing and B(2) for boating. The level of protection offered by the classification is based on the State's Antidegradation Policy which states "Existing uses of waters and the level of water quality necessary to protect those existing uses shall be maintained and protected regardless of the water's classification." And "… waters shall be managed to maintain and protect the higher water quality and minimize risk to existing and designated uses. In all cases, the level of water quality necessary to maintain and protect all existing uses as well as applicable water quality criteria shall be maintained." [14]

Public Drinking Supplies

The following are currently listed as waters that are managed for the purpose of public water supplies and designated as Class A(2) Public Water Supplies (note – the watershed delineation of Class A(2) waters can be viewed via the ANR Natural Resource Atlas from this link: http://anrmaps.vermont.gov/websites/anra5/).

Grant Brook in Ludlow is the only waterbody currently classified as A(2) that is being used for water supply. Cox and Vondell Reservoirs in Woodstock serve as emergency back-up sources only.

Appendix F. WATER QUALITY CLASSIFICATIONS **Waters**	**Aq. Biota**	**Aq. Hab.**	**Aesthetics**	**Boating**	**Fishing**	**Swim**	**Pub. WS**	**Irrigate**	**Date**	**Approx. Miles/Acres**
Grant Brook (off Jewell Brook). Abandoned - Village of Ludlow water source. Grant Brook and all waters within its watershed upstream of the flood control dam.	A1	A1	A1	A1	A1	A1	A2	B2	3/30/66	3.2 miles

All others have been abandoned as water supply sources.

[14] VWQS

Table 11. Class A(2) - Public Water Sources

Ottauquechee River	**Approx. Miles/Acres**
Spring and unnamed tributary to the Ottauquechee River. **Abandoned** - Village of North Hartland water source. A spring and unnamed tributary to the Ottauquechee River and all waters within its watershed upstream of the water intake. The spring and brook are located approximately 1 mile north-northwest of North Hartland Village.	0.3 mile
Cox, Vondell, and Carlton Hill Reservoirs. Cox and Vondell – Emergency; **Carlton Hill – Abandoned** - Village of Woodstock (WSID 5342) water sources. Cox, Vondell, and Carlton Hill Reservoirs in the Town of Woodstock and all waters within their watersheds.	2.5 miles (Stream only)
Wright, Upper Hurricane, and Lower Hurricane Reservoirs. **Abandoned** - Hartford Town (WSID 5319) water sources. Wright, Upper Hurricane, and Lower Hurricane Reservoirs and all waters within their watersheds in the Town of Hartford.	10.4 acres
Black River	
Springfield Reservoir Brook. **Abandoned** - Village of Springfield water source. Springfield Reservoir Brook and tributaries and all waters in its watershed upstream of Springfield Reservoir.	1.8 miles
Springfield Reservoir and tributaries. **Abandoned** - Village of Springfield water source. Springfield Reservoir all waters within its watershed.	9.8 acres
Unnamed tributary to Mill Brook. **Abandoned** - Village of Ascutney water source. Unnamed tributary to Mill Brook and all waters in its watershed above the water intake. The unnamed tributary is the first tributary to Mill Brook in the Town of Weathersfield.	1.7 miles

Waters that have been abandoned as water supply sources are recommended for reclassification to either A(1) or B(1) to more appropriately reflect the actual uses of the waterbody.

Table 12. Criteria for Water Classes

Use	A1	B1	B2
Aquatic Biota	Excellent - Natural Condition	Very Good - minor change	Good - moderate change
Aquatic Habitat	Natural Condition	Very Good - minor change	Good - moderate change
Aesthetics	Natural Condition	Very Good	Good
Boating	Excellent - maximum extent without degradation	Very Good - maximum extent with no more than minor degradation	Good - meets hydrological criteria
Fishing	Salmonid population in Natural Condition	Salmonid population in Very Good Condition	Salmonid population in Good Condition
Public Water Supply	(A2) Uniformly excellent character, highly suitable	---	Suitable with treatment
Swimming	Excellent	---	Good

Presently in all basins across Vermont, waters above 2,500 feet in elevation are classified A(1) by Vermont statute. A(1) may also be designated by petition or based on the water meeting biological and chemical criteria. In Basin 10 Grant Brook in Ludlow has recently been reclassified from A(2) to A(1). While it is no longer used as a direct water supply source, the brook feeds the town well field and the town petitioned to maintain a high level of protection.

Table 13 and 14 present the following waters proposed for reclassification consideration:

Reclassification Priorities

Table 13. Reservoirs Proposed for Reclassification

Waterbody	Location
A(2) to A(1) or B(1)	***These waters are no longer used or reserved for use as public water supply***
Spring and unnamed tributary to the Ottauquechee River	North Hartland
Carlton Hill Reservoirs	Woodstock
Wright, Upper and Lower Hurricane Reservoirs	Hartford
Springfield Reservoir and tributaries	Weathersfield
Unnamed tributary to Mill Brook	Ascutney

Table 14. Waters Proposed for Reclassification to A(1)

Waterbody	Location	Comments:	Supporting Data	Monitoring Needs:
B to A(1)		M - marcoinvertebrates, F - fish, RM - river mile		
A(1) - Aquatic Biota & Habitat		***These waters provide important aquatic organism life support and habitat***		
North Branch Ottauquechee River	Bridgewater, Killington - All	intact landscape throughout, extensive conserved lands, UVA or forest cover	RM 0.2 2014 – Very Good-Excellent M	1 yr M, 2 yrs F
Great Brook	Cavendish - Above Cavendish town line	data	RM 6.9 2014 Excellent M, Excellent F	1 yr M; 1 yr F
Black River Trib #9	Springfield - Above Rt. 11	data	RM 0.2 2014 & 2015 Excellent M; 2014 Excellent F; Entirely in UVA	1 yr F
Tiny Pond stream	Ludlow, Mount Holly	intact landscape thru state lands and VLT conserved land in UVA		
Kilburn Brook Trib #1	Hartford	data	RM 0.2 2011 Excellent M, Excellent F; 2014 Excellent F	1 yr M
			RM 0.6 2004 & 2008 Excellent F	2 yr M
Barnard Brook Trib 6	Pomfret	data	RM 0.4 2014 Very Good M; Excellent F	1 yr M; 1 yr F

Table 15. Waters Proposed for Reclassification to B(1)

Waterbody	Location	Comments:	Supporting Data	Monitoring Needs:
B to B(1)				
B(1) - Aquatic Biota & Habitat		***These waters provide important aquatic organism life support and habitat***		
Ottauquechee River	Bridgewater - above Bridgewater Hill Rd	data	RM 27.5 1992 & 2007 – Excellent M; 2007 – Very Good - F	current data - 1 yr M; 1 yr F
Lulls Brook	Hartland, West Windsor - above fire station	data	RM 5.9 2008 - Very Good-Excellent M & Very Good F	current data - resample M & F
			RM 6.6 2005 - Very Good-Excellent M	
			RM 6.8 2005 - Excellent M	
Great Roaring Brook	Plymouth	intact landscape thru state forest and UVA, Round Top at bottom	RM 0.1 2014 Very Good M, Excellent F	1 yr M; 1 yr F
B(1) - Fishery		***These waters provide important fish spawning and nursery habitat***		
Jewell Brook	Ludlow			
Grant Brook	Ludlow			
Sanders Brook	Ludlow			
Twenty Mile Stream	Cavendish			
North Branch Black	Cavendish – Upstream of intersection with Ascutney Basin Road			
Kent Brook	Killington - Above Kent Pond			
Falls Brook	Killington			
Ottauquechee River	Above Roaring Brook confluence			
North Branch Ottauquechee River	Bridgewater, Killington			
Roaring Brook	Killington			
Reservoir Brook	West Bridgewater	Considered major spawning tributary especially for brown trout		
Madden Brook	West Bridgewater			
Dailey Hollow Brook	Bridgewater Center			
Pinney Hollow Brook	Plymouth	Highly impacted by river channel manipulation following TS Irene. In 2016, temperature data collected by VDFW between June and October showed 0 days reaching 68°F at a site near Coolidge State Park and 60 days reaching 68°F or above just upstream of the mouth.		**Pinney Hollow Brook is a good candidate for habitat restoration**
Curtis Hollow Brook	Bridgewater			
Beaver Brook	West Woodstock			
Kedron Brook	South Woodstock			
Barnard Brook	South Pomfret			
Cloudland Brook	South Pomfret			
Babcock Brook	Taftsville			
Whitman Brook	Hartford	Considered a spawning tributary for rainbow trout. In 2016, dry conditions limited flow stranding trout in pools at lower reaches. Potential sources of water withdrawal contributing to this issue should be investigated.		
Fulling/Harlow Brook	North Hartland			

Outstanding Resource Waters

In 1987, the Vermont Legislature passed Act 67, "An Act Relating to Establishing a Comprehensive State Rivers Policy." A part of Act 67 provides protection to rivers and streams that have "exceptional natural, cultural, recreational or scenic values" through the designation of Outstanding Resource Waters (ORW). Depending on the values for which designation is sought, ORW designation may protect exceptional waters through the permits for stream alteration, dams, wastewater discharges, aquatic nuisance controls, solid waste disposal, Act 250 projects and other activities. ORWs are waters which can be designated by the Agency of Natural Resources through a petition process. ORWs display outstanding qualities that are determined to deserve a higher level of protection. ORW designation may be based on any one or more of the following features:

1. existing water quality and current water quality classification;
2. the presence of aquifer protection areas;
3. the waters' value in providing temporary water storage for flood water and storm runoff;
4. the waters' value as fish habitat;
5. the waters' value in providing or maintaining habitat for threatened or endangered plants or animals;
6. the waters' value in providing habitat for wildlife, including stopover habitat for migratory birds;
7. the presence of gorges, rapids, waterfalls, or other significant geologic features;
8. the presence of scenic areas and sites;
9. the presence of rare and irreplaceable natural areas;
10. the presence of known archeological sites;
11. the presence of historic resources, including those designated as historic districts or structures;
12. existing usage and accessibility of the waters for recreational, educational, and research purposes and for other public uses;
13. studies, inventories and plans prepared by local, regional, statewide, national, or international groups or agencies, that indicate the waters in question merit protection as outstanding resource waters; and
14. existing alterations, diversions or impoundments by permit holders under state or federal law.

There are currently no ORW waters in Basin 10. Several surface waters have been identified as prospective candidates for ORW, which are presented in Table 15. As part of the implementation of this tactical basin plan, the Department will evaluate the features and

values of these surface waters for consistency with identified in prior ORW criteria. Surface waters that satisfy criteria for designation as ORW will be proposed for such designation through public hearings and legislative rulemaking.

Table 16. Waters Proposed for designation as Outstanding Resource Water

Waterbody	Location	Comments:	
ORW	***These waters display outstanding qualities based on one or more of 14 features***		
			ORW Feature
North Branch Ottauquechee River	Bridgewater, Killington - All	Fish habitat and fishery recreation	1, 4, 12
Buttermilk Falls, Branch Brook	Ludlow		7, 8, 12
Cavendish Gorge, Black River	Cavendish		7, 8, 12
Comtu Falls, Black River	Springfield		7, 8

Class I Wetland Designation

It is policy of the State of Vermont to identify and protect significant wetlands and the values and functions they serve in such a manner that the goal of no net loss of such wetlands and their functions is achieved. Based on an evaluation of the extent to which a wetland provides functions and values it is classified at one of three levels:

Class I: Exceptional or irreplaceable in its contribution to Vermont's natural heritage and therefore, merits the highest level of protection

Class II: Merits protection, either taken alone or in conjunction with other wetlands

Class III: Neither a Class I or Class II wetland

As part of the development of this tactical basin plan, several surface waters have been identified as prospective candidates for Class I. These wetlands have passed a cursory review by the Vermont Wetlands Program Ecologists. Three wetlands warrant study for Class I potential, others for Class II. These wetlands are presented in Table 17. As part of the implementation of this tactical basin plan, the Department will develop and implement procedures and documents to enable submission, evaluation, and implementation of petitions to classify wetlands as Class I.

Those wetlands that satisfy criteria for designation may be proposed for such designation through Departmental rulemaking authority, and as consistent with the Vermont Wetland Rules.

Table 17. Prospective Candidates for Wetland Reclassification

Waterbody	Location	Comments:
Wetlands	***These waters should be assessed for potential reclassification to Class 1 or 2***	
Black Pond	Plymouth	
Beaver Pond	Weathersfield	
Killington Flats	Killington	Extensive wetlands with many strong wetland functions due to the stream (e.g., erosion control, flood storage, fish habitat, wildlife habitat) and a strong aesthetic value due to their visibility from a public road
Lake Ninevah contiguous	Mount Holly	
Eshqua Bog	Hartland	High recreational and educational value, Showy Lady-slipper, Yellow Lady-slipper, northern bog orchid, green orchid, Labrador tea, cotton grass, pitcher plants, showy lady's slippers, larches, buckbean

Existing Uses

All surface waters in Vermont are managed to support designated uses valued by the public at a level of Class B(2) or higher. These uses include swimming, boating, fishing, aquatic biota, habitat, aesthetics, drinking water supply and irrigation.

The degree of protection afforded to these uses is based on the water's class as described in above. In addition, under the anti-degradation policy of the Vermont Water Quality Standards, if the Agency of Natural Resources identifies in a waterbody, a use, the existing condition of which exceeds its classification criteria, then that use shall be protected to maintain that higher level of quality. The Agency may identify existing conditions, known as **existing uses**, of particular waters during the tactical basin planning process or on a case-by-case basis during application reviews for State or Federal permits. Consistent with the Federal Clean Water Act, the Vermont Water Quality Standards have always stipulated that existing uses may be documented in any surface water location where that use has occurred since November 28, 1975. Pursuant to the definition of the new Class B(1) in Act 79, the Agency will

identify an existing use at Class B(1) or A(1) levels when that use is demonstrably and consistently attained.

It is the Agency's long-standing stipulation that all lakes and ponds in the basin have existing uses of swimming, boating and fishing. Likewise, the Agency recognizes that fishing activities in streams and rivers are widespread throughout the state and are too numerous to document. Also recognized is that while some streams may be too small to support significant angling activity, they provide important spawning and nursery areas, which contributes to fish stocks downstream where larger streams and rivers support a higher level of fishing activity. As such, these small tributaries are considered supporting the use of fishing and are protected at a level commensurate with downstream areas.

Based on the above paragraph, the existing uses identified by DEC for the Basin to date should therefore be viewed as only a partial accounting of known existing uses based upon limited criteria. The list does not change protection under the Clean Water Act or Vermont Water Quality Standards for waters not listed. Appendix C. presents the current list of Existing Uses determined for the Basin, while Table 8 identifies those surface waters where additional data will be obtained to demonstrate the consistent attainment of Class B(1) criteria for aquatic life and wildlife.

Chapter 5 – Project Implementation: Protection and Remediation Actions

The tactical plan's implementation table identifies specific actions to address impairments, altered or stressed waters (Table 9) and waters included as priority areas at the beginning of Chapter 3. Prioritized assessment and monitoring needs are included in Table 8. Many action items reflect the primary goals and objectives identified in the Statewide Surface Water Management Strategy with the purpose of remediating or protecting waters. Others reflect regional and local concerns for water quality and habitat improvements.

This tactical plan implementation table is intended to be a working document and will be continuously updated with input from watershed partners.

The Summary of Implementation Projects presented in Table 18. addresses a broad set of actions addressing the overarching issues facing wide areas of the Basin. Specific sub-watersheds where projects are proposed are identified in some cases. Individual project details and locations can be found in the on-line Watershed Projects Database.

Projects Completed

Project implementation is on-going in the Basin. Since the previous plan was completed in 2012, 37 clean water projects have been implemented by watershed partners investing over $1,000,000 in state, municipal and private funding.

Some examples of these projects include:

Stormwater system mapping, illicit discharge detection studies and town stormwater reports are completed or underway by VDEC for 15 towns.

In the Town of Springfield this has resulted in

- expanding the sewer system to unserved residences and businesses
- purchasing of a Vactor truck to remove sediment from stormwater catch basins
- design of a stormwater detention & treatment basin for the Springfield Transfer Station
- an assesssment of Mile Brook along Valley Street to determine causes for erosion and streambank failure
- installing a raingarden for stormwater treatment by the Black River Action Team.

River corridor easements are now in place in along the Black River in Cavendish and Plymouth to protect floodplains from development.

Sediment control projects have been completed in Plymouth, Ludlow and Woodstock. And riparian buffer plantings are growing in Bridgewater, Hartford, Hartland and Woodstock.

Assessments and river corridor planning have been completed on ten rivers and streams. Leading to

- instream culverts being removed (Woodstock)
- a pond being removed to create floodplain (Reading)
- creation of a floodplain park (Woodstock)
- a floodplain restoration designed and ready to be established (Plymouth)
- a dam removed and another designed and planned for removal West Windsor).

Harrington Road dam constriction removal:

BEFORE

AFTER

Volunteers from the Black River Action Team and the Ottauquechee River Group are testing water quality on:

- Black River and its tributaries
    - North Branch
    - Mile Brook
    - Spoonerville Brook
    - Great Brook
- Ottauquechee River and its tributaries
    - Falls Brook

- North Branch
- Roaring Brook
- Kedron Brook
- Kent Brook

Between 2014 and 2017 nineteen basin towns have received over $650,000 from the Better Roads program to address road erosion projects. Another $420,000 in projects is planned and funded for 2018.

Table 18. Summary of Implementation Projects

Strategies	Priority Subbasin or Town	Stressor(s) addressed	Potential Partners
AGRICULTURE: Implement BMPs			
Increase outreach and technical assistance through workshops and trainings for farmers, ag contractors and technical service providers	Basin-wide	Land erosion, nutrients, pathogens	UVM Ext., NRCDs, AAFM, NRCS
Implement livestock exclusion practices	Kedron Brook	Land erosion, nutrients, pathogens	NRCDs, AAFM, NRCS
Increase farm buffer establishment along surface waterways and upland wetlands	Kedron Brook, No. Branch Black, Twentymile Stream	Land erosion, nutrients, pathogens, temperature	NRCDs, AAFM, NRCS
Establish long-term funding for projects like 'Trees for Streams'	Basin-wide	Land erosion, nutrients, pathogens, temperature	VDEC, NRCDs, AAFM, NRCS
Expand small farm NMP development courses and workshops, trainings for farmers, manure applicators and technical service providers	Basin-wide	Nutrients, pathogens	UVM Ext., NRCDs, AAFM, NRCS
Increase the use of cover crops	Basin-wide	Land erosion, nutrients, pathogens	UVM Ext., NRCDs, AAFM, NRCS
Identify areas in need of AEM assessment and additional BMP practices	Kedron Brook, No. Branch Black, Twentymile Stream	Land erosion, nutrients, pathogens	NRCDs, AAFM, NRCS
Provide technical assistance to the equine community to increase participation in nonpoint source pollution prevention	Kedron Brook, Mill Brook	Land erosion, nutrients, pathogens, temperature	UVM Ext., NRCDs, AAFM, NRCS
Continue outreach to farmers on the RAPs.	Basin-wide	Land erosion, nutrients, pathogens, temperature	NRCDs, AAFM

Strategies	Priority Subbasin or Town	Stressor(s) addressed	Potential Partners
Acquire RCE on farmland located on alluvial fans	Kedron Brook/Ottauquechee confluence, Hubbard Brook, No. Branch Black, Twentymile Stream, Mill Brook	Flood resiliency	VLT, VRC, UVLT
FLOW ALTERATION: Restore natural flows			
Work with dam operators to mitigate flow variations and work toward run-of-river management	Connecticut River, Ottauquechee River, Black River	Flow Alteration	USACE, Great River Hydro
Pursue conservation flows through appropriate state regulatory processes	Connecticut River, Ottauquechee River, Black River	Flow Alteration	VDEC, USACE, Great River Hydro
FOREST MANAGEMENT: Abate soil erosion			
Protect headwater streams and sensitive upland surface waters	North Branch Ottauquechee	Land erosion, Nutrient loading	DFPR, VLT, UVLT
Better manage forest road runoff through adherence to AMPs	Basin-wide	Land erosion, Nutrient loading	DFPR, ???
Continue and expand the Portable Skidder Bridge Program	Basin-wide	Land erosion, Nutrient loading	NRCDs
HAZARD MITIGATION & FLOOD RESILIENCY: Decrease threats to human safety and property damage			
Enhance the Flood Resiliency with funding for technical assistance and incentives for municipalities	Basin-wide	Flood resiliency	VEM, VDEC-Rivers
Remove sewer lines from hazardous locations including streambeds	Woodstock, Windsor	Flood resiliency	Municipalities, VDEC - FED
Buy-out properties that are highly vulnerable to flooding from willing sellers	Cavendish, Ludlow, Plymouth, Springfield, West Windsor, Windsor	Flood resiliency	VEM, FEMA. RPCs
Assess dams for structural integrity: prioritize High and Significant Hazard dams for removal or repair	Basin-wide	Flood resiliency	VDEC - FED

Implement Emergency Action Plans for all High and Significant Hazard dams	Basin-wide	Flood resiliency	RPCs, VDEC - FED

Strategies	Priority Subbasin or Town	Stressor(s) addressed	Potential Partners
IMPAIRED & STRESSED WATERS: Improve water quality and habitat restoration			
See Proposed Actions in Table 9.	Ludlow, Hartford, Killington, Springfield	stormwater runoff	landowners, municipalities
RIVER CORRIDOR: Reach stream equilibrium and flood resilience			
Increase the number of river and floodplain restoration projects to re-establish connections to floodplains	Black River, No. Branch Black, Patch Brook, Mill Brook	Land erosion, nutrients, pathogens, temperature, flood resiliency	VNRCDs, RPCs
Increase River Conservation Easements: support projects which incorporate channel management, riparian buffer provisions and flood resiliency	Basin-wide	Land erosion, nutrients, pathogens, temperature, flood resiliency	VRC, VLT, UVLT
Replace geomorphologically incompatible culvert and bridges: RPCs work with towns to identify, add to capital budget, seek additional funding sources	Basin-wide	Land erosion, nutrients, flood resiliency	VTrans, municipalities
Remove dams, esp. High Hazard dams	Basin-wide	Flow alteration, temperature, flood resiliency	CRC, RPCs, dam owners
Increase buffer plantings	Ottauquechee River, Kedron Brook, No. Branch Black, Twentymile Stream	Land erosion, nutrients, pathogens, temperature, flood resiliency	NRCDs, watershed assoc's

Strategies	Priority Subbasin or Town	Stressor(s) addressed	Potential Partners
SHORELANDS: Protect and restore			
Promote & implement the Lake Wise Program to encourage lake-friendly shoreline property maintenance	Echo Lake, others????	Land erosion, nutrients, temperature, flood resiliency	lakeshore owners, lake assoc's
Raise awareness about lake-friendly living and shoreland protection	All lakes and ponds	Land erosion, nutrients, temperature, toxics	Zoning administrators, realtors, lakeshore owners, DEC permit specialist
Establish Lay Lake Monitoring on appropriate lakes and ponds	Amherst, Echo, Kent, Knapp 1 & 2, Lakota, Mecawee, Mill (Windsor), Ninevah, Rescue, Woodward		lakeshore owners, lake assoc's
Work to control riparian and aquatic invasive plants	Hoyts Landing (Black River), Kent Pond, Mill (Windsor), Ninevah, North Hartland Reservoir, North Springfield Reservoir, Rescue	Invasives	lakeshore owners, lake assoc's
STORMWATER: Reduce pollutants and volume			
Develop stormwater master planning to identify and prioritize actions	Roaring Brook, East Roaring Brook (Killington), Okemo Brook, Trailside Brook (Ludlow) also: Hartford, Windsor, Woodstock		RPCs, NRCDs, municipalities
Implement the above plans		Land erosion, channel erosion, nutrients, pathogens, temperature, flood resiliency	RPCs, NRCDs, municipalities

Strategies	Priority Subbasin or Town	Stressor(s) addressed	Potential Partners
Assist municipalities to control runoff from gravel and paved roads: implement road assessment protocol to assist with prioritization; provide technical and financial resources to assist with implementation; implement Municipal Roads General Permit	Basin-wide	Land erosion, channel erosion, nutrients, temperature, flood resiliency	RPCs, NRCDs, municipalities
Address gully erosion from stormwater runoff	Ottauquechee River, Roaring Brook, Mill Brook	Land erosion, channel erosion, nutrients	RPCs, NRCDs, municipalities
SURFACE WATER PROTECTION: Restore and reclassify			
Monitor and assess waters with no or outdated data	see Table 8		VDEC
With partners, submit applications for reclassification	see Table 12, 13, 14, 15		RPCs, NRCDs, municipalities
Evaluate waters for ORW designation	see Table 16		VDEC
WETLANDS: Protect and restore			
Restore degraded wetlands for habitat and water quality improvement	No. Branch Black, Twentymile Stream, Mill Brook	Land erosion, nutrients, temperature, flood resiliency	RPCs, NRCDs, watershed assoc's
Assess wetlands for potential reclassification	see Table 17		VDEC - Wetlands
Map unmapped wetlands	Basin-wide		VDEC - Wetlands, RPCs

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Acronyms & Abbreviations

319	Federal section 319 grants for NPS pollution abatement
604b	Federal section 604b pass through funds
AAFM	Vermont Agency of Agriculture Food and Markets
ACCD	Agency of Commerce and Community Development
ALS	Aquatic Life Support
ANR	Vermont Agency of Natural Resources
ANS	Aquatic Nuisance Species Program
AOP	Aquatic Organism Passage
AR	American Rivers
BASS	Biological Assessment Studies Section
BFE	Base Flood Elevation
BR	Better Roads Program (VTrans)
BMP	Best Management Practices
CDBG	Community Development Block Grant
CREP	Conservation Reserve Enhancement Program
CRJC	Connecticut River Joint Commissions
CRWC	Connecticut River Watershed Council
CSO	Combined Sewer Overflow
CWIP	Clean Water Initiative Program
CWSRF	Clean Water State Revolving Fund
E	Endangered: in immediate danger of becoming extirpated in the state
EBTJV	Eastern Brook Trout Joint Venture
EPA	Environmental Protection Agency
ERAF	Emergency Relief Assistance Fund
EQIP	Environmental Quality Incentives Program
FEH	Fluvial Erosion Hazard
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
GMNF	Green Mountain National Forest
GSI	Green Stormwater Infrastructure
HMGP	Hazard Mitigation Grant Program
IBA	Important Bird Area
IDDE	Illicit Discharge Detection and Elimination
LaRosa	LaRosa Analytical Partnership Program
LE	Listed Endangered – Federal Status
LID	Low Impact Development
LIS-RCPP	Long Island Sound - Regional Conservation Partnership Program
LMM	Low Median Monthly
LT	Listed Threatened – Federal Status
MAPP	Monitoring, Assessment and Planning Program
MGD	million gallons per day

MPG	Municipal Planning Grants
NECRR	New England Central Railroad
NFIP	National Flood Insurance Program
NOAA	National Oceanographic and Atmospheric Administration
NC	Natural Community
NHDES	New Hampshire Department of Environmental Services
NPDES	National Pollution Discharge Elimination System
NPS	Nonpoint Source Pollution
NRCD	Natural Resources Conservation District
NRCS	Natural Resource Conservation Service
ONRCD	Ottauquechee Natural Resource Conservation District
ORW	Outstanding Resource Water
PFW	Partners for Fish and Wildlife Program
RAP	Required Agricultural Practices
RAS/WAS	Return Activated Sludge/ Waste Activated Sludge
RBC	Rotating Biological Contactor
RM	River Mile
RMP	River Management Program (Agency of Natural Resources)
RPC	Regional Planning Commission
RTE	Rare, Threatened and Endangered species
S1	Very rare, vulnerable to extirpation from the state
S2	Rare, vulnerable to extirpation in the state
SBR	Sequencing Batch Reactors
SGA	Stream Geomorphic Assessment
SGCN/SC	Species of Greatest Conservation Need/Special Concern
SPA	Source Protection Area for drinking water supply
SWCRPC	Southern Windsor County Regional Planning Commission
SWG	State Wildlife Grants
T	Threatened: with high possibility of becoming endangered in the near future
TBP	Tactical Basin Plan
TFS	Trees for Streams
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TNC	The Nature Conservancy
TU	Trout Unlimited
USFWS	United States Fish and Wildlife Service
USFS	United States Forest Service
USGS	United States Geological Survey
UVM Ext	University of Vermont Extension
UV	Ultraviolet light
UVLT	Upper Valley Land Trust
VAPDA	Vermont Association of Planning and Development Agencies
VDEC	Vermont Department of Environmental Conservation

VDFPR	Vermont Department of Forest Parks and Recreation
VDFW	Vermont Department of Fish and Wildlife
VDOH	Vermont Department of Health
VHCB	Vermont Housing and Conservation Board
VIP	Vermont Invasive Patrollers
VLCT	Vermont League of Cities and Towns
VLT	Vermont Land Trust
VRC	Vermont River Conservancy
VTC	Vermont Technical College
VTrans	Vermont Agency of Transportation
VTWAP	Vermont Wildlife Action Plan
VWQS	Vermont Water Quality Standards
VYCC	Vermont Youth Conservation Corps
WMA	Wildlife Management Area
WQRP	Water Quality Remediation Plan
WSMD	Watershed Management Division
WWTF	Wastewater Treatment Facility

Glossary

A full glossary is available in the Vermont Surface Water Management Strategy Glossary. Terms not listed there are included below.

Altered –Waters where a lack of flow, water level or flow fluctuations, modified hydrology, physical channel alterations, documented channel degradation or stream type change is occurring and arises from some human activity, OR where the occurrence of exotic species has had negative impacts on designated uses. The aquatic communities are altered from the expected ecological state.

Anoxic – an aquatic system totally depleted of dissolved oxygen.

Acceptable Management Practices (AMP) - measures for loggers, foresters, and landowners to utilize, before, during, and after logging operations to comply with the Vermont Water Quality Standards and minimize the potential for a discharge of pollutants from logging operations.

Aquatic Life Support (ALS) - the ability of an aquatic community or communities to meet a certain level of biological integrity that complies with Class Standards in state Water Quality Standards.

Biocriteria – is

Biological Integrity – the ability of an aquatic ecosystem to support and maintain a community of organisms that is balanced, fully functional (integrated), resilient to change or impact (adaptive), and has the expected species composition, diversity, and functional organization for its type of ecosystem.

Best Management Practices (BMP) – site specific on-farm remedies implemented either voluntarily or as required in order to address water quality problems and in order to achieve compliance with state water quality standards.

Brownfields – is real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Equilibrium or **Dynamic equilibrium** or **Equilibrium condition –** the width, depth, meander pattern, and longitudinal slope of a stream channel that occurs when water flow, sediment, and woody debris are transported by the stream in such a manner that it generally maintains dimensions, pattern, and slope without unnaturally aggrading or degrading the channel bed elevation.

Full Support – surface waters of high quality that meet all use support standards for the water's classification and water management type**.**

Head Cut (stream geomorphology) - an erosional feature of some intermittent streams and perennial streams where an abrupt vertical drop, also known as a knickpoint in the stream bed occurs. The knickpoint, where a head cut begins, can be as small as an overly-steep riffle zone or as a large as a waterfall. When not flowing, the head cut will resemble a very short cliff or bluff. A small plunge pool may be present at the base of the head cut due to the high energy of falling water. As erosion of the knickpoint and the streambed continues, the head cut will migrate upstream. (http://en.wikipedia.org)

Impaired - surface waters where chemical, physical and/or biological data collected from quality assured and reliable monitoring efforts reveal 1) an ongoing violation of one or more of the criteria in the Water Quality Standards and 2) a pollutant of human origin is the most probable cause of the violation.

Outstanding Resource Water – waters of the State designated by the Secretary as having exceptional natural, recreational, cultural, or scenic values.

Reach – a segment of river displaying similar characteristics throughout.

Required Agricultural Practices (RAP) - practices and management strategies to which all types of farms must be managed to reduce the impact of agricultural activities to water quality.

River Corridor - the land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel and that is necessary for the natural maintenance of natural restoration of a dynamic equilibrium condition and for minimization of fluvial erosion hazards, as delineated by the Agency of Natural resources in accordance with river corridor protection procedures.

Run-of-the-river mode of dam operation where instantaneous flows below the tailrace shall equal instantaneous inflow to the impoundment at all times.

Superfund site – any land in the United States that has been contaminated by hazardous waste and identified by the EPA as a candidate for cleanup because it poses a risk to human health and/or the environment.

Species of Greatest Conservation Need (SGCN) - According to federal legislation and guidance from the USFWS on the development of Comprehensive Wildlife Conservation Strategies, "each State will determine these species in the context of developing its [Wildlife Conservation Strategy]. These species must be fauna, and not flora, and may

include aquatic species and invertebrates. A State's list of "species of the greatest conservation need" may include currently listed Federal and State wildlife species and other species of concern. We anticipate that the composition of this list will change over time as the status and conservation need of species changes within the State." The term Species of Greatest Conservation Need is not a statutory designation similar to the terms "endangered" or "threatened" codified by federal and state Endangered Species Acts.

Stressed - surface waters that support the uses for the classification but the water quality and/or aquatic biota/habitat have been disturbed and these may be at risk of not supporting uses in the future.

Stressor - an observable influence with quantifiable damaging effects on surface waters resulting from the delivery of pollutants to a waterbody, or an increased threat to public health and safety.

Total Maximum Daily Load (TMDL) – is the calculation of the maximum amount of pollution a body of water can receive and still meet state water quality standards.

Water Quality Remediation Plan (WQRP) - a TMDL alternative in which pollutant sources stressing a waterbody (normally non-point sources) are identified and remediation actions believed sufficient to alleviate the problem are rapidly installed. Actions are usually tied to a completion timeline as well as follow-up monitoring to track improvement and success. WQRPs have been instituted as part of Act 250 permit requirements and 1272 Orders and are usually sufficient to preclude the development of a TMDL according to EPA regulations (i.e. 4b alternative). Oftentimes WQRPs are preferable to TMDLs because much of the modeling and loading estimate work, which can be complex and time consuming, is skipped to enable rapid assessment and deployment of BMPs.

Appendices

APPENDIX A. – Basin Planning meetings

2015

September

- Weathersfield Conservation Commission - present information about water quality, introduce the TBP process and recruit their involvement in the upcoming new plan development

2016

February

- Mill Brook High Meadows Project meeting
- TRORC and SWCRPC staff to review and discuss RPC MOU and work on B10 TBP
- SWCRPC training for municipal officials on Act 64, presented on TBP

May

- Meeting with Cavendish Conservation Committee

July

- SWCRPC Clean Water Conversations meeting
- Reading Road tour & meeting

September

- SWCRPC projects planning meeting

November

- Kedron Brook project planning meeting
- SWCRPC:
    - Clean Water Advisory Committee meeting
    - Board meeting - presented on TBP for Basin 10
    - Meeting with staff on project planning and project database
    - Weathersfield planning meeting
    - CRJC Ascutney LRS Board - presented on TBP for Basin 10

2017

January

- SWCRPC Clean Water Advisory Committee meeting

March

- Weathersfield projects planning meeting
- TRORC:
    - planning meeting for High Meadows project on the Ottauquechee River
    - Leahy Conference for High Meadows project on the Ottauquechee River
    - Clean Water Advisory Committee meeting
- Connecticut River Watershed Farmers Alliance meeting
- Meeting with NRCS, AAFM & ONRCD to discuss B10 TBP, focus areas and projects

- Met with Lakers and Pond to discuss B10 TBP, monitoring and projects

April

- SWCRPC Clean Water Advisory Committee meeting
- Connecticut River Watershed Farmers Alliance meeting
- ONRCD Local Workgroup to set TBP priorities in NRCS program applications
- Town of Weathersfield meeting with town manager, town planner and WCC chair on developing potential Black River projects in Perkinsville to enhance aquatic habitat conditions and river access

May

- Attended meeting
- Meet with staff on potential ERP projects for grant round
- Kedron Brook water quality meeting

July

- TRORPC/NRCD outreach meeting on Required Agricultural Practices and Municipal Jurisdiction
- Connecticut River Conservancy - River Recreation forum

August

- Ninevah lake visit and meeting

September

- TRORC Clean Water Advisory meeting - discuss the B10 plan progress, reclassification implications, WPD and funding opportunities
- SWCRPC Clean Water Advisory Committee meeting

October

- SWCRPC Clean Water Advisory Committee meeting
- Connecticut River Joint Commissions - Connecticut River Agriculture Clean Water Initiatives

November

- Upper Valley Land Trust project coordination meeting
-

December

- Ottauquechee High Meadows Project meeting

VERMONT

State of Vermont *Agency of Natural Resources*
Fish & Wildlife Department
100 Mineral Street, Suite 302 [cell] 802-622-4017
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Memorandum

TO: Marie Caduto; Watershed Coordinator

FROM: Lee Simard, Fisheries Biologist

DATE: June 19, 2017

SUBJECT: Black River and Mill Brook Watershed Fisheries Assessment

Black River Fisheries

The Black River basin supports a wide variety of both warm and cold-water fisheries. The mouth of the Black River and its lower reach contains many warm-water fish species as are commonly seen in the Connecticut River. The lower portion of the Black River and its lower tributaries also serve as spawning areas for wild rainbow trout populations residing in the Connecticut River and native anadromous sea lamprey, a species of greatest conservation need (SGCN) which migrate up the Connecticut River from the Atlantic Ocean. Other SGCN including redbreast sunfish and anadromous American shad also utilize the lower Black River downstream of the Lovejoy Dam, although the number of American shad that have passed above the Bellows Falls fish ladder has only begun to increase in recent years.

Upstream portions of the Black River mainstem and its tributaries above the Cavendish Dam, are managed for wild brook trout (a SGCN), and brown trout populations. However, portions of the Black River mainstem downstream of the dam are managed as a "put and take" fishery due to high water temperatures throughout the summer months which prevent the establishment of wild trout populations or the long-term survival of stocked trout. Average water temperatures measured on the Black River mainstem in Weathersfield by the Vermont Department of Fish and Wildlife in 2015 at 622-feet in elevation above sea level generally exceeded 70°F throughout the summer, and maximum seven-day mean water temperatures commonly reached nearly 83°F (Will 2016; Figures 1, 4). Temperatures above 70 F are unsuitable for brook trout. Brown trout can tolerate warmer temperatures up to 80 F, but only for short periods of time.

Several lakes exist along the mainstem of the Black including North Springfield Reservoir (96 acres), Rescue Lake (224 acres), Echo Lake (100 acres), Amherst Lake (83 acres), and Black Pond (20 acres). These lakes and ponds provide fishing opportunities. Lake Rescue, Echo Lake, and Amherst Lake located along the mainstem of the Black River are stocked annually. Each lake receives rainbow trout, lake trout are added to Echo Lake and Lake Rescue, and brown trout are added to Lake Rescue. These lakes also support other fish species including yellow perch, chain pickerel, rock bass, largemouth bass, smallmouth bass,

brown bullhead, black crappie, and rainbow smelt. Boat access is provided at all three lakes via access areas maintained by the Vermont Fish and Wildlife Department.

Colby Pond (21 acres), located in Plymouth along the headwaters of Twenty Mile Stream, is stocked annually with rainbow and brown trout. Rock bass and golden shiners are also present. A Vermont Fish and Wildlife Department boat access ramp is located at Colby Pond.

Knapp Pond #1 (30 acres), Knapp Pond #2 (42 acres), and Stoughton Pond (560 acres), located on the North Branch of the Black River, are also stocked annually; Stoughton Pond and Knapp Pond Number 1 are stocked with rainbow trout while Knapp Pond Number 2 is stocked with brook trout. Stoughton Pond is a popular largemouth bass fishery. High turbidity levels in the pond following Tropical Storm Irene led to heavy sedimentation that reduced aquatic vegetation and smothered other important habitat, potentially negatively impacting the bass population in subsequent years (Cox 2012, Cox 2014).
Other species including yellow perch, golden shiner, white sucker, and pumpkinseed are also present in Stoughton Pond. Fathead minnow, a popular bait species, was discovered in both Knapp Ponds in 2007, likely following an illegal introduction; the use of baitfish for fishing, either alive or dead, was prohibited at the Knapp Ponds until 2011. Vermont Fish and Wildlife boat access ramps are provided at both Knapp Ponds. A boat ramp maintained by the US Army Corps of Engineers is located at Stoughton Pond.

Black River Characteristics:

The mainstem of the Black River is highly impounded. Thirteen total dams (Table 1) are located along the mainstem of the Black River. Many additional dams are located on tributaries to the Black River, including four flood control and storm water management dams along Jewell Brook and its tributaries, all highly productive trout streams.

There are five hydroelectric facilities currently operating along the Black River, with the majority occurring in the downtown Springfield area (Table 1). These facilities have the potential to entrain and impinge fish, which can cause mortality of riverine species. At least one of these facilities (Slack Dam) regularly interrupts flows which can draw down water levels and impact aquatic biota. Historically, a surface level downstream passage pipe was required under the Atlantic salmon Restoration Program to convey Atlantic salmon smolts through the system. The Agency has been requiring their continued use during the spring and fall for resident species pursuant to the LIHI certification. However, their effectiveness has not yet been tested.

There is also one flood control facility operated by the Army Corps of Engineers (North Springfield Reservoir), which regulates flows on the Black River. Reduced peak discharges and generally stable flows produced by regulated water releases from reservoirs inevitably impact natural stream processes including channel morphology and substrate composition.

The impacts of dams and their associated impoundments on the physical, chemical, and biological processes within and downstream of the waters that they impound are well documented. These dams and their associated impoundments alter the natural hydrology and sediment transport of the system and can impact water quality, especially water temperature. These structures also either limit or prevent passage of fish and other aquatic organisms. Maintaining a connected system allows fish to seek the best available habitat for

reproductive needs, food resources, thermal refuge and cover. Aquatic connectivity also allows for the recolonization of upstream habitats after catastrophic events, such as floods or toxic discharges. Furthermore, free movement within a river system helps to maintain genetic diversity of aquatic populations. During periods of stressful environmental conditions, fish will often migrate to cold-water

refuges such as the mouths of tributary streams or to areas of groundwater inflow during warm periods. Similarly, trout may migrate in the fall to areas providing suitable overwintering or spawning habitat. Local fish populations may be impacted by these barriers if the populations are unable to access these areas.

Other structures, such as poorly designed culverts, can also act as barriers to aquatic organism passage and degrade aquatic ecosystems. Of the 418 culverts that have currently been assessed in the Black River watershed, only 6.2% are fully passable by aquatic organisms. The failure potential and flood risk associated with culverts should also be evaluated in addition to evaluating aquatic organism passage. Factors including bankfull width, the level of sediment continuity, slope of the structure relative to the surrounding stream, approach angle of the stream, and the amount of erosion and armoring can all affect the performance and failure potential of a culvert during high flow events.

Mill Brook Fisheries

Mill Brook is considered a cold-water fishery and supports native populations of brook and brown trout. Population estimates from two annual sampling sites on Mill Brook in recent years indicate trout populations are generally stable, but low relative to more productive waters in the state with an average of only 120 and 71 catchable (>6 inches) trout per mile between 2013 and 2016 at the Mill Brook sites located at elevations 810 and 1048 feet above sea level located in the towns of West Windsor and Reading, respectively. Brook trout are currently stocked annually through an approximately 1.2 mile stretch of Mill Brook along the West Windsor and Reading town line. Other fish species present in Mill Brook include northern redbelly dace, fathead minnow, blacknose dace, longnose dace, white sucker, longnose sucker, creek chub, and slimy sculpin.

Windsor Upper Dam is located approximately 1 mile upstream of the Connecticut River along Mill Brook in the town of Windsor. The impoundment, Mill Pond, is a popular recreational area for swimming, boating, and fishing. Mill Pond is stocked annually with rainbow trout and brown trout. The pond also contains white sucker, longnose sucker, brown bullhead, golden shiner, common shiner, creek chub, yellow perch, bluegill, and fallfish.

Many of the stream crossings along the mainstem of Mill Brook are bridges or arches and provide full aquatic organism passage. However, of the 19 culverts that have currently been evaluated within the Mill Brook watershed, none are fully passable. The failure potential and flood risk associated with culverts should also be evaluated in addition to evaluating aquatic organism passage. Factors including bankfull width, the level of sediment continuity, slope of the structure relative to the surrounding stream, approach angle of the stream, and the amount of erosion and armoring can all affect the performance and failure potential of a culvert during high flow events.

Water temperatures in Mill Brook are generally conducive to trout populations. In 2015, water temperatures briefly reached 70°F at both sampling sites in Mill Brook, but only had maximum 7-day means around 68°F (Will 2016; Figures 2, 3).

Management Opportunities

1. Work to improve riparian corridors and thermal conditions: Elevated water temperatures (Figures 1, 4) can be moderated through instream and riparian cover. Much of the mainstem of the Black River, especially from the confluence of the Connecticut River upstream through Springfield, is highly developed and has little to no vegetated riparian corridor. Improving or providing riparian corridors along the main stem of the Black River and its tributaries, especially in highly developed areas, would help shade the stream and maintain cooler water temperatures needed for trout. Advocating for dam removal, where

appropriate, would also improve water temperatures as impoundments created by dams increase water surface area enhancing exposure to solar radiation.

2. Work to improve aquatic habitat connectivity: Providing aquatic connectivity by evaluating and replacing culverts which impede access to the cooler tributaries would benefit native species that have the propensity to seek thermal refuge in the warm summer months. Advocating for dam removal, where appropriate, would also improve aquatic connectivity through the system. To maintain or improve aquatic connectivity, downstream passage for resident fish species should continue to be provided at all hydroelectric facilities within the watershed. Continuing to maintain or improve these passage facilities would greatly benefit other species.

3. Work to improve instream habitat complexity and diversity: Post-Tropical Storm Irene impacts, including berming, instream channelization, and removal of instream cover including boulders and wood inevitably impacted aquatic biota. Windshield surveys following Irene identified nearly 12,500 feet of major impacts and over 2,500 feet of minor impacts along the mainstem and North Branch of the Black River and over 3,000 feet of major impacts along the mainstem of Mill Brook and Bailey Brook, a headwater tributary. Other tributaries within the basins were not evaluated. Complex and diverse habitat is essential to healthy ecosystems. Restoring instream complexity and access to floodplains would improve the overall quality of the system leading to positive impacts on fish populations (Kirn 2012). Additionally, addressing areas with sediment runoff and erosion will help benefit streams and riparian ecosystems.

4. Work to improve flows: Maintaining or improving flow management at hydroelectric and existing flood control facilities would benefit downstream species. Rapid fluctuations in flows can strand fish or displace them downstream. Fluctuations may also expose or destroy spawning areas containing eggs or newly hatched fish, including those of native spawning sea lamprey. Hydro-electric facilities should continue to be operated in run-of river mode. Efforts should be made to require continuous flow at hydro-electric facilities that are known to cause interruptions.

5. Work to stop the spread of exotic species and pathogens: A variety of non-native fish species and harmful pathogens are present in Vermont or surrounding states. Preventing future introductions of these exotic species and pathogens will allow healthy fisheries to continue.

6. Work to identify and designate B1 High Quality Fishing – Wild Salmonid Streams
The VDFW assesses wild trout populations and important spawning and nursery areas to document reaches which support very high quality recreational fisheries, which are typically found in surface waters that exhibit cool water temperatures and complex habitat conditions. Abundant wild trout populations are defined as supporting multiple age classes of one or more species of wild trout (brook, brown, rainbow trout) at levels generally equal to or greater than 1,000 fish/mile and/or 20 pounds/acre. It should be recognized that wild trout populations vary widely from year to year and therefore an individual population may sometimes go below or greatly exceed these values in a given year. Other waters that have not been surveyed may also support similar wild trout densities and should be identified in the future. Certain streams also support important spawning and nursery habitat. Based upon fish population surveys conducted by VDFW these fisheries exist in the following waters:

- • ***Jewell Brook*** - Ludlow
- • ***Grant Brook*** **-** Ludlow
- • ***Sanders Brook*** – Ludlow
- • ***Twenty Mile Stream*** **-** Cavendish
- • ***North Branch Black*** – Upstream of intersection with Ascutney Basin Road

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Cox, K. 2012. District I black bass survey summary – Stoughton Pond, Vermont Fish and Wildlife Department Federal Aid in Fish Restoration Annual Report, F-36-R-14.
Cox, K. 2014. District I – Stoughton Pond, Vermont Fish and Wildlife Department Federal Aid in Fish Restoration Annual Report, F-36-R-16.
Kirn, R. 2012. Impacts to stream habitat and wild trout populations in Vermont following Tropical Storm Irene. Vermont Fish and Wildlife Department Federal Aid in Fish Restoration, F-36-R-14. Montpelier.
Will, L. 2016. District I stream temperature monitoring. Vermont Fish and Wildlife Department Federal Aid in Fish Restoration Annual Report, F-36-R-18.

Tables and Figures

Dam Name	Town	Hazard Potential	Purpose
Lovejoy	Springfield	Low	Hydroelectric
Slack	Springfield	Low	Hydroelectric
Comtu Falls	Springfield	Low	Hydroelectric
Gilman	Springfield	Low	Hydroelectric
Fellows	Springfield	Low	Hydroelectric
North Springfield	Springfield	High	Flood Control
Soapstone	Weathersfield	Low	Hydroelectric
Cavendish	Cavendish	Low	Hydroelectric
Okemo Snow Pond Diversion Structure	Ludlow	Low	Snow Withdrawal
Reservoir Pond	Ludlow	Low	Recreation
Lake Rescue	Ludlow	Low	Recreation
Amherst Lake	Plymouth	Significant	Recreation
Black Pond	Plymouth	Low	Recreation

Table 1: Artificial dams located along the mainstem of the Black River, Windsor County

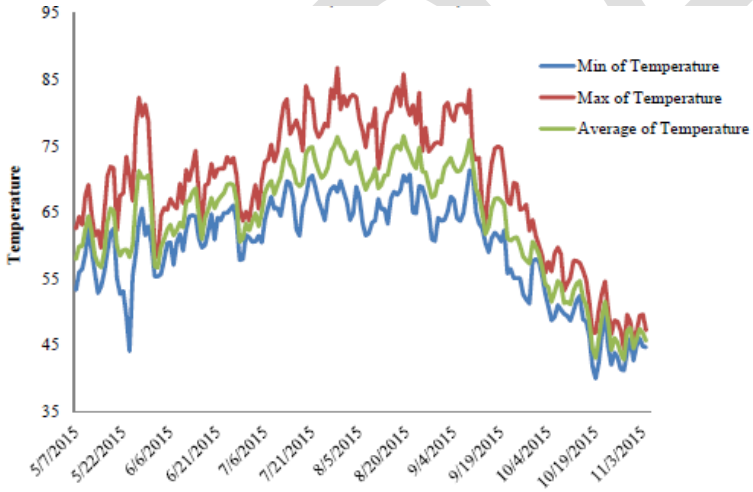

Figure 1: Daily mean, minimum, and maximum water temperatures recorded from May 7 to November 4, 2015 along the Black River trophy trout section in Cavendish, Vermont located at 622-feet in elevation above sea level.

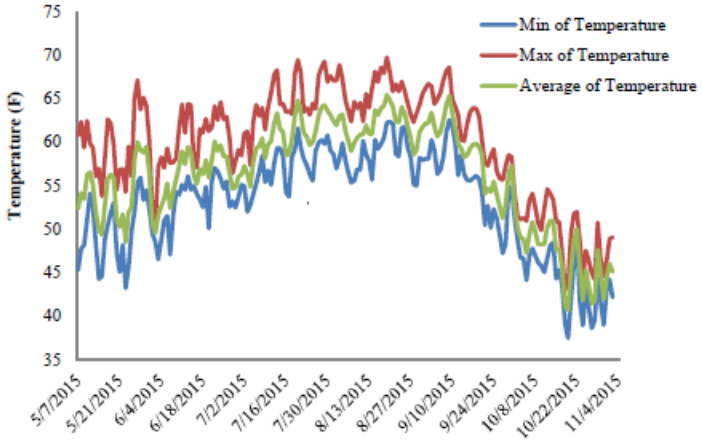

Figure 2: Daily mean, minimum, and maximum water temperatures recorded from May 7 to November 4, 2015 on Mill Brook just downstream of the confluence with Bailey Brook in Reading, Vermont located at 1048-feet in elevation above sea level.

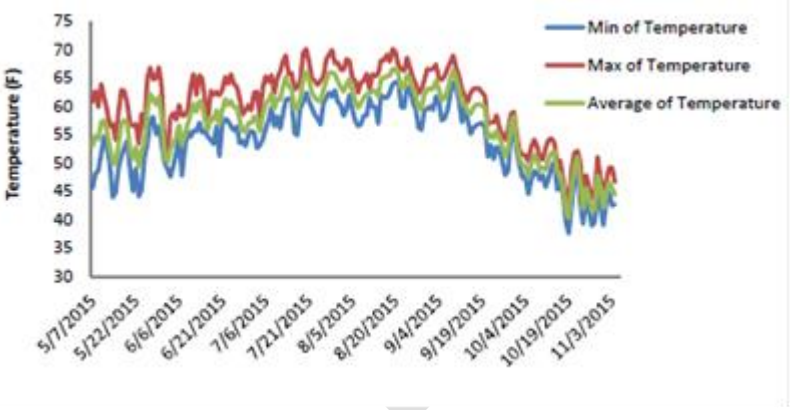

Figure 3: Daily mean, minimum, and maximum water temperatures recorded from May 7 to November 4, 2015 in Mill Brook in West Windsor, Vermont located at 810-feet in elevation above sea level.

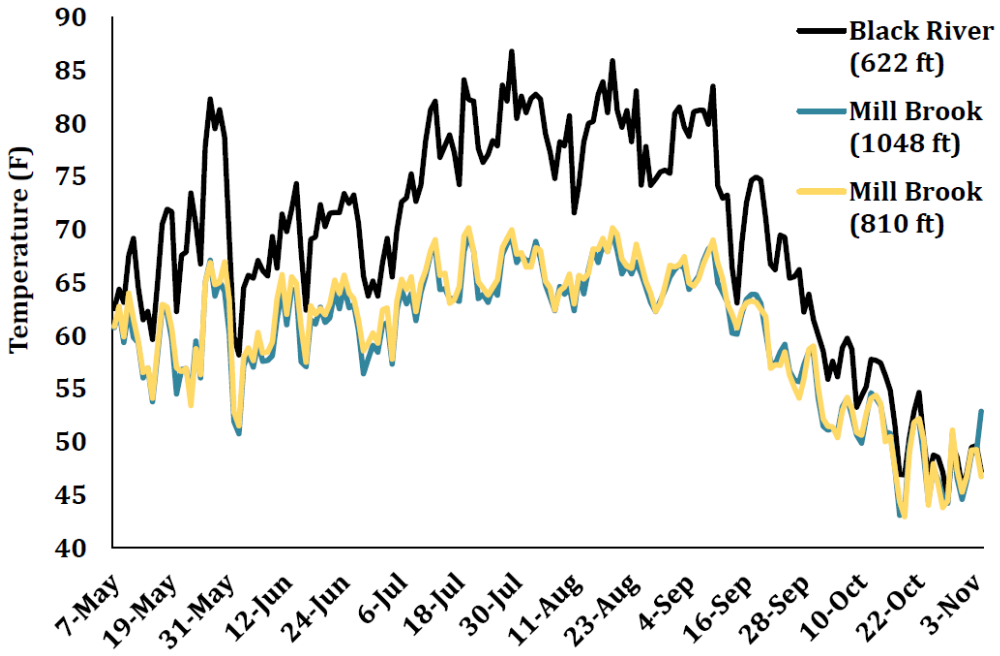

Figure 4: Comparison of daily maximum water temperatures recorded from May 7 to November 4, 2015 for the Black River trophy trout section in Cavendish, Vermont at 622-feet in elevation, Mill Brook just downstream of the confluence with Bailey Brook in Reading, Vermont at 1048-feet in elevation, and Mill Brook in West Windsor, Vermont at 810-feet in elevation.

cc. *Rich Kirn, Fisheries Program Manager*
Lael Will, Fisheries Biologist

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TO: Marie Caduto; Watershed Coordinator

FROM: Bret Ladago; Fisheries Biologist

DATE: January 3, 2017

SUBJECT: Ottauquechee Watershed Fisheries Assessment

Ottauquechee Fisheries:

A variety of fish species exist within the Ottauquechee River basin, many of which support a popular recreational fishery. Naturally reproducing (wild) native brook trout are common in colder, higher elevation tributaries and within the mainstem above West Bridgewater. Wild populations of brown trout and rainbow trout are less common, but present within individual tributaries and mainstem reaches. The mainstem below West Bridgewater supports low wild trout populations, likely due to temperature limitations and poor habitat quality. In 2016, VDFW (Vermont Department of Fish and Wildlife) observed mainstem water temperatures exceeding 80°F at 7 locations between Bridgewater and Hartford (Table 1) and maxim temperatures exceeded 85°F above Dewey's Mill Pond (upper end of Highland Golf Course). In 2005, maximum water temperature at the same location exceeded 88°F and reached 80°F or above on 29 days (Table 1). Hatchery-reared trout are stocked annually by VDFW within the Ottauquechee River from Bridgewater Corners (Junction of Rt.4 & 100) to the Taftsville Dam and provide angling opportunity in areas with limited wild trout populations. Tributary streams are not stocked and managed as wild trout waters.

Several unnatural barriers exist within the mainstem of the Ottauquechee that limit fish migration, impact water quality and alter sediment transport and natural hydrology. During times of stressful environmental conditions, trout may seek tributary streams as refuge. For example, trout often migrate to cold-water refuges such as the mouths of tributary streams or to areas of groundwater inflow during warm periods. Similarly, trout may migrate in the fall to areas providing suitable overwintering or spawning habitat. Large barriers prevent these migrations and may impact local populations.

Impassable artificial barriers within the mainstem of the Ottauquechee River include:

Taftsville Dam – Taftsvillle
Downers Mills (Simon Pearce) – Woodstock
Deweys Mills – Woodstock
North Hartland Dam – North Hartland
White Current Dam – North Hartland

In addition to large structures, small dams and poorly designed culverts can prevent ecological connectivity and degrade aquatic ecosystems. VDFW assessed 211 culverts within the Ottaquechee drainage and found that only 7% were fully passable to fish. Furthermore, only 1.4% of culverts assessed were measured equal to or wider than bank full width, which could indicate increased flood risk and structure failure potential.

The Ottauquechee River below the North Hartland Dam to its confluence with the Connecticut River is designated warm water fish habitat. The fish community includes largemouth bass, smallmouth bass, pumpkinseed, rock bass, tessellated darter, longnose dace, bluntnose minnow, lake chub, common shiner, and fathead minnow. Abrupt flow fluctuations within this reach due to peaking operations of the North Hartland Hydroelectric project likely impact fish populations and other aquatic biota (Figure 1). The FERC license for this facility will expire in 2024. VFWD is currently involved in the relicensing process and is working with VDEC and facility owners (Concord Hydro Associates) to improve conditions.

Lake and Pond habitat within the Ottauquechee basin is primarily composed of man-made waterbodies. Only one natural pond (View Pond) exists within the basin and three others (Woodward Reservoir, Lakota Lake, and the Pogue) are naturally occurring with artificial controls. Of these natural waterbodies, only Woodward Reservoir offers public access (VDFW owned access area). Woodward Reservoir provides fishing opportunities for largemouth bass, smallmouth bass fisheries, brown trout (stocked), rainbow trout (stocked), brown bullhead, chain pickerel, northern pike, rainbow smelt, white sucker, rock bass, and yellow perch. Woodward reservoir also serves as a water supply for snowmaking operations at Killington.

Man-made ponds within the Ottauquechee basin that provide public access and recreational fishing opportunity include:

Kent Pond - (VDFW owned dam and access area) - Fishery includes largemouth bass, pumpkinseed, brook trout (stocked), rainbow trout (stocked), brown bullhead, white sucker, and yellow perch.

Vondell Reservoir - Stocked annually with rainbow trout; rudd are also present.

Deweys Mill Pond - (Recreational access provided by the Army Corps of Engineers) Fish community includes largemouth bass, northern pike, brown bullhead, pumpkinseed, bluegill, rock bass, white sucker, bluntnose minnow, fall fish, golden shiner, creek chub and rudd. One black crappie was found by F&W personnel in 2014 during an electrofishing survey.

North Hartland Reservoir - (Recreational access provided by the Army Corps of Engineers) – Fish community includes northern pike, brown bullhead, largemouth bass, pumpkinseed, rock bass, white sucker, yellow perch, and rudd. Rainbow trout were stocked annually until 2012. In 2016 maximum water temperatures exceeded 80ºF and temperatures reached 75ºF or above on 90 or 55 days between June and October depending on the depth within the reservoir (Table 1).

To maintain quality fisheries, the continued protection and enhancement of aquatic habitat is required including:

- *Naturally vegetated riparian areas* – Undisturbed riparian areas provide a host of essential functions and values including filtering pollutants, maintaining cool water temperatures, recruiting natural wood and other organic materials, preventing erosion, and providing food and shelter for fish and other aquatic organisms. These benefits are realized not only within the protected stream reach, but also in the downstream receiving waters.
- *Habitat connectivity* – The movement of fish and other aquatic populations to critical feeding, spawning, and refuge habitats is hindered by dams and poorly designed culverts. Removing dams and replacing impassible culvers is vital to improve connectivity
- *Sedimentation* – Preventing sediment runoff and erosion help the benefit stream and riparian ecosystems.
- *Natural hydrologic regimes* – Regulated stream flows from hydroelectric facilities and water withdrawals can reduce habitat availability and quality in reservoirs and downstream reaches. Lake elevation fluctuations often negatively affect littoral zone habitats and can impact fish and other aquatic populations.
- *Preventing the introduction of exotic species and pathogens* – A variety of non-native invasive aquatic species and harmful pathogens are present in Vermont or surrounding states. Limiting the spread of these detrimental species will help maintain healthy fisheries.
- *Habitat complexity* – Complex and diverse habitat is essential to healthy ecosystems. The removal of woody habitat and alteration of stream channels following tropical storm Irene lead to over 48,500 feet of stream habitat degradation primarily within the North Branch and Broad Brook drainages of the Ottauquechee basin.

VDFW assesses wild trout populations and important nursery areas to document very high quality recreational fisheries, which are typically found in surface waters that exhibit clean and cool conditions. Abundant wild trout populations are defined as supporting multiple age classes of one or more species of wild trout (brook, brown, rainbow trout) at levels generally equal to or greater than 1,000 fish/mile and/or 20 pounds/acre. It should be recognized that wild trout populations vary widely from year to year and therefore an individual population may sometimes go below or greatly exceed these values in a given year. Other waters that have not been surveyed may also support similar wild trout densities and may be identified in the future. Certain noteworthy streams are also important to support spawning and nursery habitat. Based upon fish population surveys conducted by VDFW these fisheries exist in the following waters:

- ***Kent Brook*** - Above Kent Pond (Killington)
- ***Falls Brook*** (Killington)
- ***Ottauquechee River*** (Above Roaring Brook confluence)
- ***Roaring Brook*** (Killington)
- ***Reservoir Brook*** (West Bridgewater) - Considered major spawning tributary especially for brown trout
- ***Madden Brook*** (West Bridgewater)
- ***Dailey Hollow Brook*** (Bridgewater Center)
- ***Pinney Hollow Brook*** (Plymouth) – Highly impacted by river channel manipulation following tropical storm Irene. In 2016, temperature data collected by VDFW between June and October showed 0 days reaching 68°F at a site near Coolidge State Park and 60 days reaching 68°F or above just upstream of the mouth.

Pinney Hollow Brook is a good candidate for habitat restoration

- ***Curtis Hollow Brook*** (Bridgewater)
- ***Beaver Brook*** (West Woodstock)
- ***Kedron Brook*** (South Woodstock)
- ***Barnard Brook*** (South Pomfret)
- ***Cloudland Brook*** (South Pomfret)
- ***Babcock Brook*** (Taftsville)
- ***Whitman Brook*** (Hartford) - Considered a spawning tributary for rainbow trout. In 2016, dry conditions limited flow stranding trout in pools at lower reaches. Potential sources of water withdrawal contributing to this issue should be investigated.
- ***Fulling/Harlow Brook*** (North Hartland)

Table 1. Water temperature metrics (°F) measured between June and October for multiple locations along the Ottaquechee River and within North Hartland Reservoir.

Town	Location Description	Elevation (feet MSL)	Year	Days >65F	Days >68	Days >72	Days >75	Days >80	Max Temp
Sherburne	Sherburne Center	1170	2016	89	70	20	2	0	76.1
Bridgewater	West Bridgewater	1060	2016	93	56	13	1	0	75.7
Bridgewater	Abv North Branch	860	2016	93	70	31	5	0	76.6
Bridgewater	Blw Broad Brook	830	2016	105	93	66	41	6	81.6
Woodstock	Abv Taftsville dam	640	2016	109	101	84	59	16	84.4
Woodstock	Blw Taftsville dam	610	2016	108	96	75	43	3	80.3
Hartford	Abv Deweys Mill Pond	570	2016	110	104	92	67	29	85.6
Hartford	Abv Deweys Mill Pond	570	2005	107	97	79	62	29	88.4
Hartford	Quechee Gorge	460	2016	110	104	88	63	13	82.4

Hartford	In N. Hartland Res - 5ft Deep	420	2016	115	109	100	90	32	84.0
Hartford	In N. Hartland Res - 10ft Deep	410	2016	109	105	82	55	2	80.4

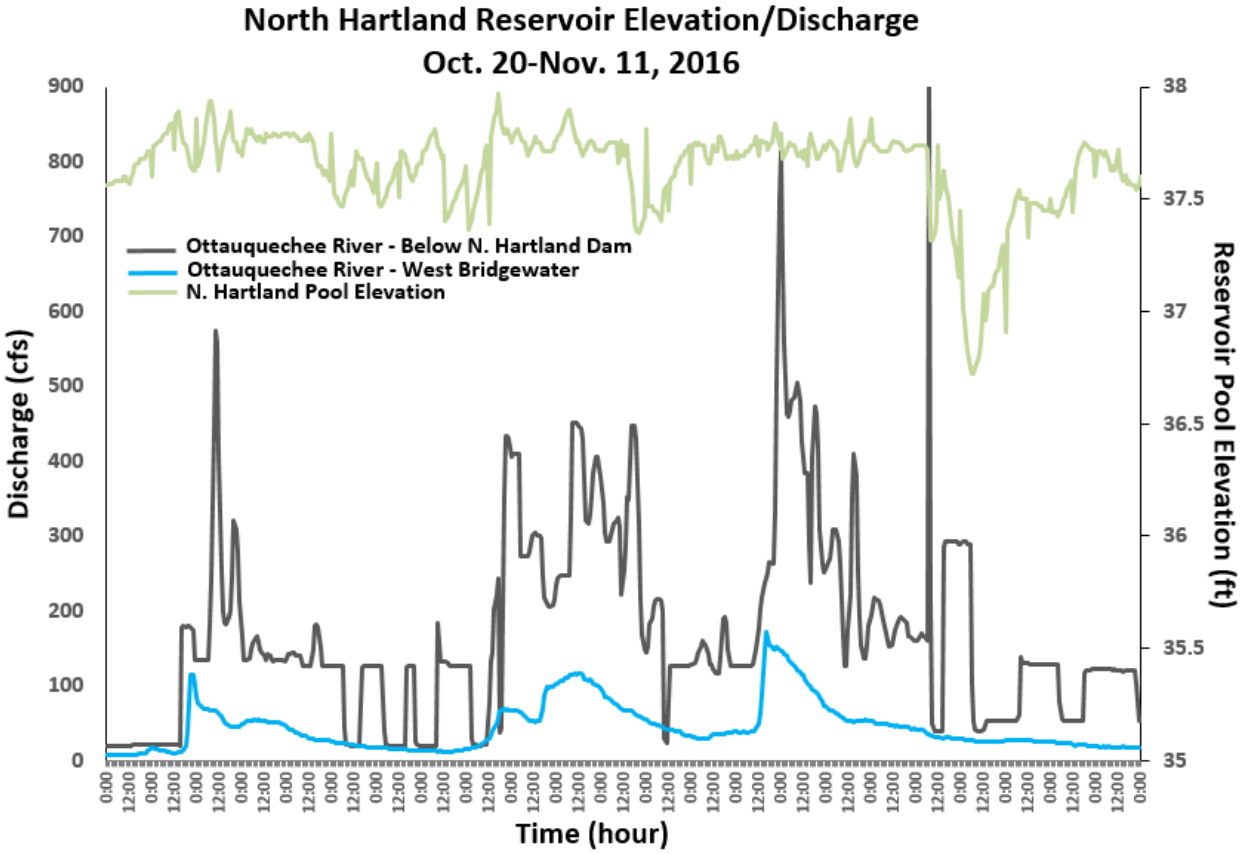

Figure 1 – Pool elevations of North Hartland Reservoir and hourly discharge measurements from the Ottauquechee River upstream in West Bridgewater and downstream below the North Hartland Dam between October 20, 2016 and November 11, 2016.

cc. *Rich Kirn, VDFW*

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Memorandum

TO: Marie Caduto, Watershed Coordinator

FROM: Lael Will, Fisheries Biologist

DATE: 2/23/2017

SUBJECT: Black River

Management Strategy

The mainstem of the Black River in Weathersfield and Cavendish is managed as a "Put and Take" fishery because while spring flows are ideal, and access is excellent, summer water temperatures are some of the highest in our District. For example, out of the 20 streams we monitor for stream temperatures, this portion of the Black is the warmest, with maximum temperatures reaching 87 degrees (Figure 1). Recent angler survey data conducted at this site indicate that the fishery is functioning as intended (a popular short-term fishery with little impact to wild trout populations).

Recent creel surveys indicate that the current management strategy provides high catch rates, high levels of fish "recycling" increasing the value of each trout stocked, while allowing anglers to harvest their daily limit of two fish. Furthermore, environmental conditions in this portion of the Black River would not allow anglers to realize the benefits of delayed harvest or no kill regulations.

Habitat conditions: This portion of the Black experiences temperatures in which duration, frequency and magnitude are not suitable for trout. For example, the Black River is heavily impounded and includes the North Springfield Reservoir (96 acres), Rescue Lake (224 acres), Echo Lake (100 acres), Amherst Lake (83 acres), and Black Pond (20 acres). Although the upper Black River mainstem and tributaries support wild brook and brown trout populations, the lower river is too thermally impaired to neither support wild trout populations nor provide for the long-term survival of stocked trout.

Habitat Improvements: Efforts should be made to improve the thermal conditions of the Black River. This could be accomplished by advocating for dam removal (where appropriate), and improving riparian corridors. Providing aquatic connectivity by evaluating and replacing culverts which impede access to the cooler tributaries would benefit native species that have the propensity to seek thermal refuge in the warm summer months. Lastly, post-Irene channelization should be analyzed to identify stream reaches that may benefit from instream habitat improvements (e.g. boulder placement). A channel that mimics natural conditions (pre-Irene) and provides instream channel roughness will improve the physical habitat conditions. However, without adequate stream temperatures this strategy is likely going to have negligible benefits to cold-waters species such as trout.

If you require more clarification or have any questions regarding these recommendations, please do not hesitate to contact me.

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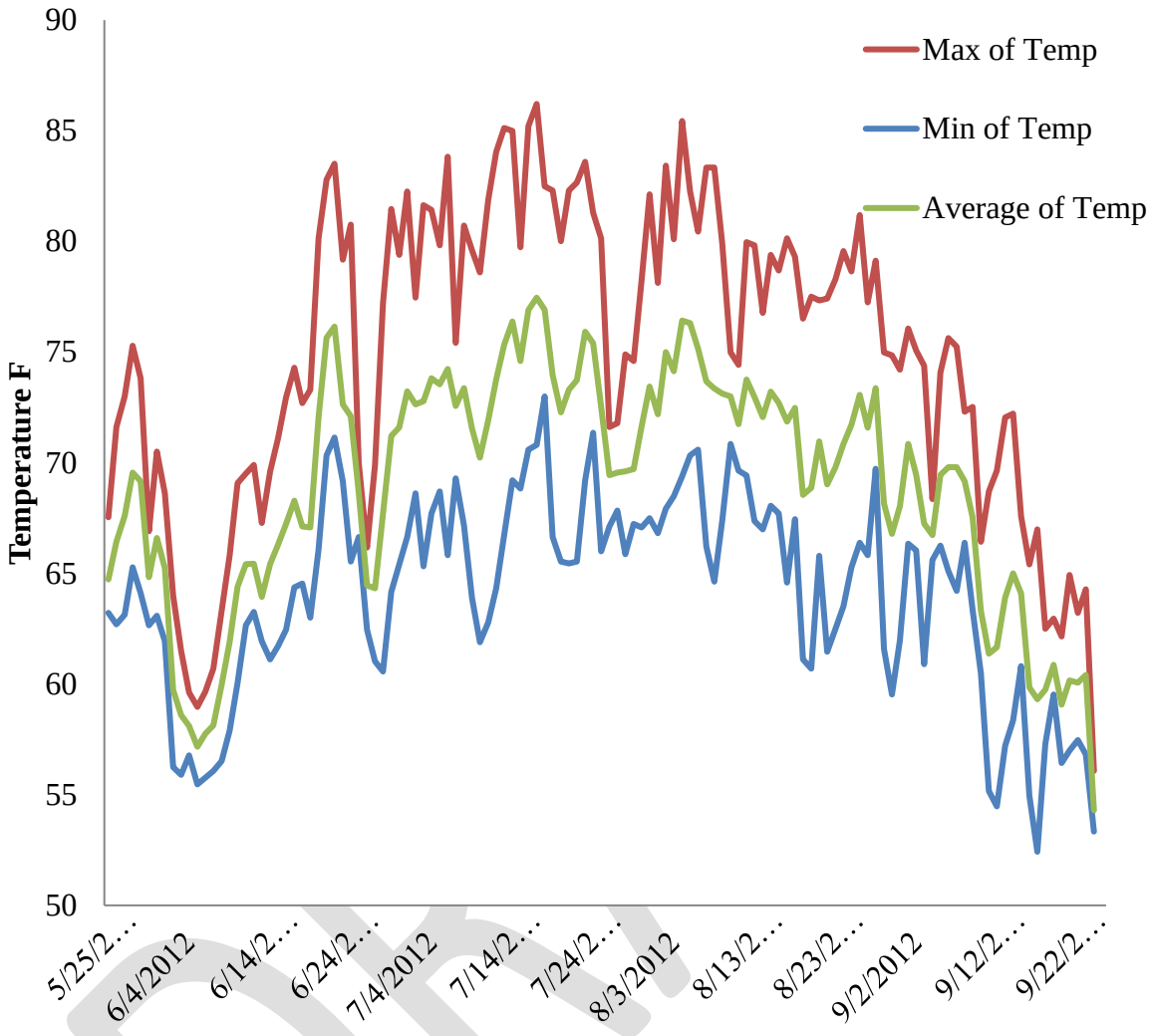


Figure 3. Daily maximum, minimum and mean water temperatures in the Black River, Weathersfield VT 2013

APPENDIX C. – Existing Uses in Basin 10 Waters

Boating

Waterbody	Reach	Public Access - Put In	Take Out
Black River Watershed			
Black River	Lake Pauline (Reservoir Pond) to Cavendish	Lake Pauline Dam	Greven Field
Black River	Cavendish to Weathersfield	Greven Field	Upper Falls Covered Bridge
Black River	Weathersfield to No. Springfield	Upper Falls Covered Bridge	USACE Rec. area
Black River	No. Springfield to Springfield Plaza	USGS Gaging Station, Mill Rd.	Plaza walking bridge
Black River	Springfield to Connecticut River	Welcome Park	Hoyts Landing
North Branch Black	Branch Brook Rd to Stoughton Pond Dam	USACE lands	USACE lands
Ottauquechee River Watershed			
Ottauquechee River	West Bridgewater to Woodstock	Blackies Buy-out	Bridges Rd. iron bridge crossing
Ottauquechee River	Woodstock to Taftsville	Bridges Rd. iron bridge crossing	River Rd. above Taftsville Dam
Ottauquechee River	Taftsville to Connecticut River	Taftsville Dam	Willard Covered bridge
Connecticut River Watershed			
Connecticut River	White River to Ottauquechee River	Lyman Point Park Launch	Ottauquechee Launch
Ottauquechee River	Ottauquechee River to Black River	Ottauquechee Launch	Hoyt's Landing
Connecticut River	Black River to Williams River	Hoyt's Landing	Herricks Cove

Contact Recreation

Waterbody	Site	Location of Use	Town	Ownership
Black River Watershed				
Black River	RR Bridge	RR bridge crossing Cavendish village, ~350 below RR bridge	Cavendish	RR ROW
Black River	Cavendish Gorge	~300' below CVPS Cavendish dam	Cavendish	CVPS
Black River	Carlton Rd Crossing	~100' north D/S of Carlton Rd bridge	Cavendish	unknown (ROW)
Black River	Power Plant Rd	~500' below the end of Power Plant Rd	Cavendish	CVPS
Black River	Tolles Hill Dam Area	USACE No. Springfield Recreation Area	Weathersfield	USACE
North Branch Black River	Bartley Field Rec Area	Bartley Field	Reading	Town of Reading
North Branch Black River	Twenty-Foot Hole	Tyson Rd. access	Reading	VDFPR / VRC
North Branch Black River	Branch Brook Rd.	Branch Brook Rd. end	Weathersfield	USACE
Branch Brook	Buttermilk Falls	Buttermilk Falls	Ludlow	VDFPR / VRC
Ottauquechee River Watershed				
Ottauquechee River	Bridgewater Rec Park	Park riverfront	Bridgewater	Town of Bridgewater
Ottauquechee River	River Road --- Woodstocker's Rope Swing	River Rd. ~500' east of Otis Hill Rd.	Hartford	Town of Hartford
Ottauquechee River	Quechee Gorge	Bottom end of gorge, ~2250' below Rte 4 bridge	Hartford	USDOD/VDFPR
Ottauquechee River	Quechee Covered Bridge	Below Covered Bridge	Hartford	Town of Hartford ROW
Ottauquechee River	Elm St. Bridge	Below Elm St. bridge crossing	Woodstock	Town of Woodstock
Harlow Brook	Clay Hill Rd. Hole	Clay Hill Rd. crossing	Hartland	USACE

Contact Recreation

Connecticut River Watershed				
Connecticut River	Wilgus State Park	Park riverfront	Weathersfield	VDFPR
Connecticut River	Sumners Fall	Town access	Hartland	Town of Hartland

Fishing

Rivers & Streams

Rivers and Streams	Town	County	Table	Ice Fishing Table	Map	Stream Section #	ANS*
(Including tributaries, bays, and setback to first highway bridge)	All Applicable Towns	All Applicable Counties	4		4, 7, 8, 11, 13, 15		E
Ottauquechee River							
Connecticut River main channel to first highway bridge crossing, Hartland.	Hartland	Windsor	4		11	62	
First highway bridge crossing, Hartland, to Headwaters.	All Applicable Towns	All Applicable Counties	1		11		
Black River							
Black River along Route 131 in Weathersfield and Cavendish, from Downers covered bridge upstream (approximately 4 miles) to the next bridge across the river, the Howard Hill bridge.	Weathersfield/Cavendish	Weathersfield/Cavendish	1		13	7	
Brook, Brown, and Rainbow Trout: length limit, none; daily limit, 2 trout aggregate							
From Nov. 1 to Friday before the second Saturday in April, open ONLY TO TROUT FISHING *(Catch and Release)* using artificial flies and lures							
Howard Hill bridge to headwaters	All Applicable Towns	All Applicable Counties	1		13		
Connecticut River							
main channel to I-91 bridge, Hartland.	Hartland	Windsor	4		13	45	
I-91 bridge, Hartland, to Headwaters.	Hartland	Windsor	1		13		

Fishing

Lakes and Ponds

Lakes and Ponds	Town	County	Table	Ice Fishing Table	Map	Lake Area (acres)	Access [1]	Aquatic Nuisance Species[2]	Internal Combustion Boat Motors Allowed[3]	Other Boating Restrictions
Amherst Lake	Plymouth	Windsor	2	8	13	81	St		Y	
Black Pond	Plymouth	Windsor	2	8	13	20			N	5mph
Colby Pond	Plymouth	Windsor	5	6	13	20	St		Y	5mph
	Only open to fishing from second Saturday in April to Oct. 31 *(see table for regulations on specific species)*									
Deweys Mill Pond	Hartford	Windsor	2	8	11	56		E	N	5mph
Echo Lake	Plymouth	Windsor	2	10	13	104	St		Y	
	Open to fishing year-round *(see below and table for regulations on specific species)* Brook, Brown, Rainbow, and Lake Trout, Landlocked Salmon, and Largemouth and Smallmouth Bass: Ice Fishing Open Season: third Saturday in Jan. to March 15									
Kent Pond	Killington	Rutland	2	8	10	99	St	E	Y	5mph
	Largemouth Bass: length limit, no minimum length. 10” to 12” protected slot *(all bass 10” to 12” must be released);* daily limit, 10 bass, only 1 greater than 12”									
Knapp Brook Pond No. 1	Cavendish/Reading	Windsor	5	6	13	25	St		Y	5mph
	Only open to fishing from second Saturday in April to Oct. 31 *(see table for regulations on specific species)*									
Knapp Brook Pond No. 2	Cavendish/Reading	Windsor	5	6	13	35	St		Y	5mph
	Only open to fishing from second Saturday in April to Oct. 31 *(see table for regulations on specific species)*									

Fishing

Lakes and Ponds

Mill Pond (Kennedys Pond)	Windsor	Windsor	2	8	13	77	Mt	E	N	5mph
North Hartland Reservoir	Hartland	Windsor	2	8	11	215	Gt	E	Y	
North Springfield Reservoir	Springfield	Windsor	2	8	13	290	Gt	E	Y	5mph
Pinneo Lake	Hartford	Windsor	2	8	11	50			N	5mph
Reading Pond	Reading	Windsor	2	8	13	22			N	5mph
Rescue Lake	Ludlow	Windsor	2	10	13	180	St		Y	
	Open to fishing year-round *(see below and table for regulations on specific species)* Brook, Brown, Rainbow, and Lake Trout, Landlocked Salmon, and Largemouth and Smallmouth Bass: ice fishing open season, third Saturday in Jan. to March 15									
Reservoir Pond (Lake Pauline)	Ludlow	Windsor	2	8	13	32			Y	5mph
Runnemede Lake (Evarts Pond)										No Boating or Swimming
Stoughton Pond	Weathersfield	Windsor	5	6	13	56	Gt		Y	5mph
	Only open to fishing from second Saturday in April to Oct. 31 *(see table for regulations on specific species)*									
Tiny Pond	Ludlow	Windsor	2	8	13	29			Y	5mph
Woodward Reservoir	Plymouth	Windsor	2	8	13	106	St		Y	5mph

[1] S=State; M=Municipal; G=Federal; U=Utility; P=Private; f=foot or carry in; ud=undeveloped; t=boats on trailer; c=cartop; r=regulated.

[2] E=Eurasian Watermilfoil; Z=Zebra Mussel; W=Water Chestnut; V=Variable-leaf watermilfoil; LBV=Largemouth Bass Virus; A=Alewife.

[3] The rule prohibits the use of internal combustion motors to power vessels.

Aquatic nuisance species (ANS) spread-prevention practices should always be employed when visiting ANY waterbody, regardless of whether a known infestation is present. Invasive species and/or fish diseases could be present but not yet detected. Please follow the recommendations to help stop the spread of ANS.

Water Supply

FROM: Vermont Water Quality Standards, Environmental Protection Rule Chapter 29A

Appendix F. WATER QUALITY CLASSIFICATIONS **Waters**	**Aq. Biota**	**Aq. Hab.**	**Aesthetics**	**Boating**	**Fishing**	**Swim**	**Pub. WS**	**Irrigate**	**Date**	**Approx. Miles/Acres**
Ottauquechee, Black (Basins 10 & 13)										
Ottauquechee River										
Spring and unnamed tributary to the Ottauquechee River. Abandoned - Village of North Hartland water source. A spring and unnamed tributary to the Ottauquechee River and all waters within its watershed upstream of the water intake. The spring and brook are located approximately 1 mile north-northwest of North Hartland Village.	A2	A2	A2	A2	A2	A2	A2	B2	11/16/67	0.3 mile
Cox, Vondell, and Carlton Hill Reservoirs. Cox and Vondell – Emergency; Carlton Hill – Abandoned - Village of Woodstock (WSID 5342) water sources. Cox, Vondell, and Carlton Hill Reservoirs in the Town of Woodstock and all waters within their watersheds.	A2	A2	A2	A2	A2	A2	A2	B2	11/16/67	2.5 miles (Stream only)
Grant Brook (off Jewell Brook). Abandoned - Village of Ludlow water source. Grant Brook and all waters within its watershed upstream of the flood control dam.	A1	A1	A1	A1	A1	A1	A2	B2	3/30/66	3.2 miles

Appendix F. WATER QUALITY CLASSIFICATIONS **Waters**	**Aq. Biota**	**Aq. Hab.**	**Aesthetics**	**Boating**	**Fishing**	**Swim**	**Pub. WS**	**Irrigate**	**Date**	**Approx. Miles/Acres**
Black River										
Springfield Reservoir Brook. Abandoned - Village of Springfield water source. Springfield Reservoir Brook and tributaries and all waters in its watershed upstream of Springfield Reservoir.	A2	A2	A2	A2	A2	A2	A2	B2	3/30/66	1.8 miles
Springfield Reservoir and tributaries. Abandoned - Village of Springfield water source. Springfield Reservoir all waters within its watershed.	A2	A2	A2	A2	A2	A2	A2	B2	3/30/66	9.8 acres
Unnamed tributary to Mill Brook. Abandoned - Village of Ascutney water source. Unnamed tributary to Mill Brook and all waters in its watershed above the water intake. The unnamed tributary is the first tributary to Mill Brook in the Town of Weathersfield.	A2	A2	A2	A2	A2	A2	A2	B2	7/1/71	1.7 miles

APPENDIX D. – Municipal Planning and Water Resources Review

Town	Flood Regulations	Floodway Conditions	Special Flood Hazard Area Conditions	Flood Regulations Last Updated	NFIP	Flood Resiliency Element	River Corridor Protection	Road and Bridge Standards	Local Hazard Mitigation Plan	LHMP Expiration Date	LEOP	ERAF Rate (%)
Baltimore	Flood Hazard Area Regulations	No FEMA identified Special Flood Hazard Area within town.	No FEMA identified Special Flood Hazard Area within town. Locally designated areas.	2009	Yes	Yes	Interim	Yes	Yes	10/12/2017	Yes	17.5
Barnard	Unified Zoning and Subdivision: Flood Hazard Overlay District	Encroachments and development prohibited	New development, new fill, and storage prohibited. Non-substantial improvements allowed.	2012	Yes	Yes	Interim	Yes	In Progress	5 years from FEMA approval	Yes	7.5
Bridgewater	Flood Hazard Area Regulations	Development prohibited, and only minor improvements allowed	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse, release, and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; and service facilities located in areas to prevent water from entering.	2006	Yes	No	No	Yes	Yes	8/4/2020	Yes	12.5
Cavendish	Flood Hazard Area Regulations	Encroachments and development prohibited. Improvements within existing footprint allowed. Functionally dependent buildings allowed.	New construction and substantial improvement 1' above BFE.	2007	Yes	Yes	No	Yes	Yes	10/12/2017	Yes	12.5

Town	Steep Slope/Ridgeline Development	Stormwater/LID Requirements
Baltimore	No adverse impact under Conditional Use Review. Subdivisions standards say…"shall not ordinarily be subdivided."	Section 7.7 enables the PC to require stormwater management plans, sediment/erosion control plans. Section 7.9 requires that subdivisions be designed to minimize grading, cut and fill, to retain, insofar as possible, the natural contours, limit stormwater runoff, and conserve the natural cover and soil
Barnard	Town Plan includes an objective to "protect steep slopes and ridgelines from inappropriately sited development," a goal to "ensure slopes greater than 25 degrees should remain predominantly in forest cover," "development in these areas should be permitted only if it can be demonstrated that it will have safe access and not be detrimental to the environment," and a recommendation that "future revisions to the Zoning Bylaw should consider using elevation in restricting development." The Zoning Bylaw prohibits digging or creating pits on steep slopes, it says that "disturbance of steep slopes greater than 25% shall be minimized," and it requires subdivisions on slopes greater than 25% to require a licensed professional engineer to certify that they do not pose a landslide or erosion risk.	Subdivisions standards state that stormwater shall be handled by an erosion control plan prepared by a licensed professional engineer for control of erosion, sediment, and runoff during and following development. Conditional use development standards require stormwater and erosion control and state that drainage must control stormwater runoff, prevent erosion, and protect neighboring land and roads from undue impacts. No increase is allowed in off-site stormwater runoff in terms of volume or peak discharge.
Bridgewater	One of the Town Plan objectives is "to protect steep slopes, soils, forests, water, and other natural resources and provide open spaces for wildlife and habitat." Steep slopes are considered a Critical Natural Area of the Town, and policies in the Plan state that steep slopes should remain predominantly in forest cover, that development of steep slopes should be considered carefully in order that it not be detrimental to the environment, and land above 2,500 feet should be maintained predominantly in a natural wilderness state. As a portion of the Rural Area land use section, the plan includes slopes greater than 15% as lowdensity areas.	None
Cavendish	No zoning	No zoning

Town	Flood Regulations	Floodway Conditions	Special Flood Hazard Area Conditions	Flood Regulations Last Updated	NFIP	Flood Resiliency Element	River Corridor Protection	Road and Bridge Standards	Local Hazard Mitigation Plan	LHMP Expiration Date	LEOP	ERAF Rate (%)
Chester	Unified Bylaws - Article 6 - Flood Damage Prevention Standards	Development and encroachments in Floodway are prohibited unless demonstrated by an engineer that no increase in flood levels will occur.	New construction and substantial improvement 1' above BFE.	2014	Yes	Flood Hazard Section	No	Yes	Yes	5/6/2021	Yes	12.5
Hartford	Flood Hazard Area Regulations	Development prohibited.	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse, and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; and service facilities located in areas to prevent water from entering.	2007	Yes	Yes	No	Yes	Yes	7/23/2019	Yes	12.5
Hartland	Flood Hazard Area Regulations	No fill, storage areas, and new development prohibited	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed, operated, and anchored to prevent flotation, collapse, release, and movement of structure, chemicals, or hazardous materials; constructed with materials resistant to flood damage; construction methods that minimize flood damage; service facilities located in areas to prevent water from entering; and located so as to minimize conflict with floodwaters and natural channel movement.	2007	Yes	Yes	No	Yes	Yes	8/4/2020	Yes	12.5
Ludlow	Flood Hazard Area Regulations (includes Local Flood Hazard Areas)	New Development is prohibited in the Floodway. Substantial improvements require conditional use review.	New structures and substantial improvements require conditional use review. 1' of BFE. Establishes small stream setbacks for named streams.	2014	Yes	Yes	No	Yes	Yes	10/12/2017	Yes	12.5

Town	Steep Slope/Ridgeline Development	Stormwater/LID Requirements
Chester	Development on slopes >25% requires conditional use review.	Section 3.7 requires erosion prevention and sedimentation control during construction.
Hartford	Hartford's Zoning Ordinance contains the Rural Lands, Agricultural Lands, and Wildlife Connector Overlay District which state that development should be located down-slope of ridgelines and prominent hills in areas where ridgelines and hillsides are easily visible from existing roadways, and development shall be considered relative to the availability of less visible locations on-site.	Hartford's Zoning Regulations require a conditional use permit which will be issued given that a proposed project disturbs the least possible riparian vegetation, erosion and sediment control methods are followed, and development manages and treats stormwater runoff to filter pollutants. Specific applications for development must include a description of the practices that will be used to protect water quality of stormwater runoff and an erosion control plan. Hartford's subdivision regulations require: a project provide an adequate stormwater drainage system with culverts and drainage areas that accommodate runoff from the development's upstream drainage area or a 25 year storm event (a 4% chance of occurring annually); a project expose the smallest possible area possible at any one time during development; land should not be left exposed during winter months; temporary vegetation or mulching and structural measures may be required to protect exposed areas; sediment basins shall be installed and maintained to remove sediment from entering runoff; 4 inches of topsoil shall be provided to cover all finished slopes; and embankments are to be planted with stabilizing ground cover and seeded with grass to prevent erosion.
Hartland	Hartland's Town Plan includes a policy to prohibit development on slopes steeper than 25% unless development will not be harmful to the environment or health of the community. A second policy states that development on slopes from 15-25% require special provisions to make sure they do not result in erosion or sedimentation	Hartland's Town Plan includes recommendations that development proposals should be designed to minimize the amount of impermeable surfaces and provide for on-site stormwater treatment to enable groundwater recharge, and that the Town of Hartland will continue to participate in Act 250 and other State permit application reviews to ensure that approvals are conditioned on proper water quality protection safeguards. This will include locating activities and structures at least a 50-foot buffer from surface waters, with a larger setback distance in areas of steep slope or highly erodible soils; requirements for a detailed erosion and sedimentation control plan demonstrating proper controls during and after construction; a detailed stormwater management plan with appropriate stormwater treatment; and other recommended land use management practices.
Ludlow	Section 490 Ridgeline Protection Overlay District	Stormwater management/erosion control plans may be required for projects subject to the ridgeline overlay provisions

Town	Flood Regulations	Floodway Conditions	Special Flood Hazard Area Conditions	Flood Regulations Last Updated	NFIP	Flood Resiliency Element	River Corridor Protection	Road and Bridge Standards	Local Hazard Mitigation Plan	LHMP Expiration Date	LEOP	ERAF Rate (%)
Plymouth	Zoning Ordinance: Flood Hazard Protection Overlay	Development prohibited, and only improvements to existing structures allowed.	Includes the River Corridor: new principal structures and new net fill are prohibited.	2013	Yes	No	Interim	Yes	Yes	8/4/2020	Yes	17.5
Pomfret	Flood Hazard Area Regulations	Development prohibited, and only minor improvements allowed	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; and service facilities located in areas to prevent water from entering.	2007	Yes	No	No	Yes	In Progress	5 years from FEMA approval	Yes	7.5
Reading	Flood Hazard Area Regulations	Development in the floodway is prohibited unless demonstrated by an engineer that no increase in flood levels will occur.	Residential - at or above BFE. Non-Residential - at or above 1' above BFE.	2007	Yes	Yes	Currently Considering	Yes	Yes	10/12/2017	Yes	12.5
Springfield	Flood Hazard Review	Development in the floodway is prohibited unless demonstrated by an engineer that no increase in flood levels will occur.	New construction and substantial improvement 1' above BFE.	2014	Yes	Currently in adoption process (as of 8/18/16)	Currently Considering	Yes	Yes	10/12/2017	Yes	12.5
Weathersfield	Flood Hazard Area Regulations	Development in the floodway is prohibited unless demonstrated by an engineer that no increase in flood levels will occur.	New construction and substantial improvement 1' above BFE.	2013	Yes	No	No	Yes	Yes	10/12/2017	Yes	12.5

Town	Steep Slope/Ridgeline Development	Stormwater/LID Requirements
Plymouth	Plymouth's Town Plan identifies areas of high elevation above 2,500 feet and steep slopes greater than 15% as Significant Natural and Fragile Areas. It contains a policy to "protect steep slopes and ridgelines from inappropriately sited development" and a recommendation that steep slopes shall remain predominantly forest cover and development will be allowed only if it can be demonstrated that it will not be detrimental to the environment. The Town Plan also states that residential development in the Village, Vacation-Resort, Mountain-Recreational, and Rural Residential zoning districts/land areas shall avoid steep slopes and high elevations. It also states that development on ridgelines shall not break the silhouette of the hill. Plymouth's zoning ordinance says that subdivisions shall exclude from development land that has steep slopes greater than 25%.	Commercial and Industrial conditional use standards in the Zoning Ordinance require that parking lots shall be bordered with a buffer area landscaped in a manner that integrates the parking area with an overall landscaping plan for the site, and that the removal of existing trees shall be minimized to integrate the site with the surrounding landscape and to enhance environmental quality.
Pomfret	Pomfret's Zoning Ordinance consists of a Ridgeline and Hillside Conservation Area, which includes all land within 750 feet from primary ridges. The Ordinance identifies the importance of ridges and hillsides to the scenic quality of Pomfret, the rural and pastoral character and personality of the Town, and to the current and future well-being of Pomfret's residents. It states that the preservation and conservation of Pomfret's ridges and hillsides are essential to maintaining Pomfret's rural and pastoral character, and that the protection of this natural beauty in Pomfret's landscape is a matter of public use. Development and use of these areas should be in a manner which will not detract from nor adversely affect the scenic qualities of the Town, and development should take place in a manner compatible with important natural environmental assets of the Town.	None
Reading	None - But there is a Ridgeline Protection Overlay District	Stormwater provisions apply to mineral extraction operations under Section 4.5.
Springfield	Slopes over 20% require erosion control and stormwater management plans.	Grading and drainage plan is required part of application for site plan, current use and flood hazard review. Erosion control and stormwater management provisions apply to many types of development, including mobile home parks, filling of low areas, steep slopes (20%+), and modifying the buffer standards.
Weathersfield	Development shall cause minimal disturbance to the natural landscape in areas of slopes over 25%	Adequate provisions shall be made for the management of erosion, sedimentation and storm water runoff. For all projects undergoing Site Plan Review, except one- or two-family dwellings, appropriate storm water management measures shall be incorporated into the final site design. The Zoning Board of Adjustment may require a storm water management and erosion control plan.

Town	Flood Regulations	Floodway Conditions	Special Flood Hazard Area Conditions	Flood Regulations Last Updated	NFIP	Flood Resiliency Element	River Corridor Protection	Road and Bridge Standards	Local Hazard Mitigation Plan	LHMP Expiration Date	LEOP	ERAF Rate (%)
West Windsor	Flood Hazard Area Regulations	Development in the floodway is prohibited unless demonstrated by an engineer that no increase in flood levels will occur.	New construction and substantial improvement 1' above BFE.	2012 (but currently working to update)	Yes	Yes	No	Yes	Yes	10/12/2017	Yes	12.5
Woodstock Town	Zoning Regulations: Flood Hazard District	Development prohibited.	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse, and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; adequately drained to reduce exposure to flood hazards; and located so as to minimize conflict with floodwaters and natural channel movement.	2010	Yes	Yes	No	Yes	Yes	8/21/2020	Yes	12.5
Woodstock Village	Zoning Regulations: Flood Hazard District	Development prohibited.	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse, and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; and service facilities located in areas to prevent water from entering.	2012	Yes	Yes	No	Yes	Yes	8/21/2020	Yes	12.5

Town	Steep Slope/Ridgeline Development	Stormwater/LID Requirements
West Windsor	Development on slopes >25% requires DRB review and an erosion and sedimentation control plan under Section 3.5.	See Section 3.5.
Woodstock Town	The Zoning Regulations include a Steep Slopes and Fragile Soils portion of the Conservation District. General standards for planned development state that proposed development shall provide for the preservation of steep slopes; that buildings should not be located in sensitive areas such as steep slopes; that development shall not result in adverse impact on fragile environments (which includes steep slopes); and that steep slopes are priority areas where clearing should be avoided to protect wildlife habitat, prevent erosion, and prevent sedimentation resulting from stormwater runoff. Development on slopes greater than 15% require conditional use review, and development, regrading, and clearing of vegetation is prohibited on slopes with a grade greater than 25%. Development on slopes greater than 15% shall be sited, constructed, and slopes stabilized to minimize risks to surface waters; house sites, sewage, and parking shall be located on the flattest portion of the land; and development of roads and driveways should minimize crossing steep slopes and should follow topographic contours to minimize soil and vegetation disturbance.	Article VI in Zoning Regulations: Stormwater-Low Impact Development requires permit applications to include a condition site assessment, an erosion & sediment control plan, and a stormwater management plan. Low impact development design is preferred. Development must minimize land disturbance; preserve natural areas; and manage water, prevent erosion, and control sediment during construction according to pre-development and construction site standards. Development is also subject to stormwater management standards that include vegetative and landscaping controls that naturally manage surface runoff, standards for building on steep slopes, strategies to reduce impervious surfaces, and low impact integrated management practices.
Woodstock Village	The Conservation District in the Zoning Regulations includes Steep Slopes over 25%. Lots with steep slope characteristics as identified in the overlay zone shall be reviewed for suitable sewage disposal, access for emergency vehicles, drainage, and erosion control. New development that adds more than 10,000 sq. ft. of impervious area - roofs, decks, patios and driveways - shall be reviewed to ensure on-site retention of stormwater.	Applications for development shall include the location of facilities for the control and disposal of stormwater. Zoning Regulations include a Conservation District that aims to reduce the impact of stormwater runoff and prevent soil erosion.

APPENDIX E. – Dams in Basin 10

Dams of the Black River Watershed					
Dam Name	Stream	Town	Dam Status	State ID	Hazard Class
Powerhouse	Black River	Springfield	Breached	194.13	N/A
Vermont Snath	Black River	Springfield	Breached	194.14	N/A
Lovejoy	Black River	Springfield	In Service	194.06	Low
Slack (Lower)	Black River	Springfield	In Service	194.05	Low
Comtu Falls	Black River	Springfield	In Service	194.04	Low
Gilman	Black River	Springfield	In Service	194.03	Low
Fellows	Black River	Springfield	Not in use	194.02	Low
Muckross	Black River tributary	Springfield	In Service	194.08	Low
Springfield-11	Black River tributary	Springfield	----	194.11	Low
Springfield-10	Black River tributary	Springfield	----	194.1	Low
Springfield-9	Black River tributary	Springfield	----	194.09	N/A
Carey	Black River tributary				Significant
North Springfield	Black River	Springfield	In Service	194.01	High
Springfield Reservoir	Black River tributary	Weathersfield	In Service	229.02	Significant
Perkinsville	Black River	Weathersfield	Breached	229.04	???Low
Soapstone	Black River	Weathersfield	----	229.03	Low
Atherton	Black River	Cavendish	Breached	44.07	N/A
Cavendish 11	Twenty Mile Stream	Cavendish	Breached	44.11	N/A
Colby Pond	Twenty Mile Stream	Plymouth	In Service	156.06	Low
Cavendish	Black River	Cavendish	In Service	44.01	Low
Parker Brothers	Black River	Cavendish	Breached	44.09	N/A
Murdoch	Black River	Cavendish	Breached	44.02	N/A
Black Bear Woolen Co	Black River	Cavendish	Breached	44.1	N/A
Smithville	Black River	Ludlow	----	117.11	???N/A
Jewell Brook Site No. 3	Jewell Brook tributary	Ludlow	In Service	117.04	High
Jewell Brook Site No. 3 Dike	Jewell Brook tributary	Ludlow	In Service	117.12	Low
Jewell Brook Site No. 5	Sanders Brook	Ludlow	In Service	117.05	High
Jewell Brook Site No. 2	Grant Brook	Ludlow	In Service	117.06	High
Jewell Brook Site No. 1	Jewell Brook	Ludlow	In Service	117.07	High

Okemo Snow Pond Diversion Structure	Black River	Ludlow	In Service	117.15	Low
Okemo Snow Pond	Black River – off stream (OS)	Ludlow	In Service	117.13	High
Branch Brook	Branch Brook tributary	Mount Holly	In Service	135.03	Low
Reservoir Pond	Black River	Ludlow	In Service	117.02	Low
Lake Rescue	Black River	Ludlow	In Service	117.01	Low
Lacoss	Patch Brook tributary	Plymouth	In Service	156.12	Low
Lake Ninevah	Patch Brook	Mount Holly	In Service	135.01	Significant
Plymouth-8	Patch Brook tributaryy	Plymouth	In Service	156.08	Low
Reading Pond	Reading Pond Brook	Reading	Breached	163.02	N/A
Amherst Lake	Echo lake tributary	Plymouth	In Service	156.05	Significant
Duck Pond	Black river tributary	Plymouth	Breached (partial)	156.11	N/A
Plymouth Notch Snowmaking Pond	Black River – OS	Plymouth	In Service	156.1	Significant
Black Pond	Black River	Plymouth	In Service	156.02	Low
Stoughton Pond	North Branch Black River	Weathersfield	In Service	229.01	Significant
Widow Hill	North Branch Black River tributary	Cavendish	In Service	44.06	Low
Knapp Brook Site #1	Knapp Brook	Cavendish	In Service	44.04	Significant
Knapp Brook Site #2	Knapp Brook	Cavendish	In Service	44.05	Significant
Mile Brook	Mile Brook	Springfield	----	Unmapped	Unknown

Dams of the Ottauquechee River Watershed					
Dam Name	Stream	Town	Dam Status	State ID	Hazard Class
White Current	Ottauquechee River	Hartland	In Service	95.05	Low
Hartland-6	Ottauquechee River	Hartland	----	95.06	N/A
North Hartland	Ottauquechee River	Hartland	In Service	95.01	High
Quechee Mills	Ottauquechee River	Hartford	In Service	94.01	Low
Deweys Mills	Ottauquechee River	Hartford	In Service	94.02	Low
Taftsville	Ottauquechee River	Woodstock	In Service	254.05	Low
Deweys Pond	Ottauquechee River TR	Hartford	In Service	94.07	Low
Sunny Acres	Ottauquechee River TR	Hartland	In Service	95.04	Low
Lake Pinneo	Ottauquechee River TR	Hartford	In Service	94.08	Low
Crystal Pond	Happy Valley Brook TR	Hartland	In Service	95.06	Low
Cox Reservoir	Ottauquechee River TR	Woodstock	In Service	254.03	Significant
Vondell Reservoir	Vondell Brook	Woodstock	In Service	254.02	Significant
Carlton Reservoir	Ottauquechee River TR	Woodstock	In Service	254.04	Significant
Sherburne 14	Reservoir Brook TR	Killington	In Service	188.14	Low
Woodward Reservoir	Reservoir Brook	Plymouth	In Service	156.01	High
Rockefeller	Woodward Reservoir TR	Plymouth	In Service	156.07	Significant
Johnson	Ottauquechee River TR	Killington	In Service	188.08	Low
Sunrise Village Lagoon	Falls Brook TR	Killington	In Service	188.15	Low
Bear Pond	Falls Brook TR	Killington	In Service	188.16	Low
Mirror Lake	Roaring Brook TR OS	Killington	In Service	188.06	Low
Snowshed Pond	Roaring Brook TR OS	Killington	In Service	188.07	Significant
Thundering Falls	Kent Brook	Killington	In Service	188.2	Low
Sherburne 5	Kent Pond TR	Killington	In Service	188.05	???
Kent Pond	Kent Brook	Killington	In Service	188.09	Significant
Pico Pond	Kent Pond TR	Killington	Deleted	188.17	N/A
Connors Pond	Kedron Brook TR	Woodstock	In Service	254.09	Significant

Mecawee Pond	Broad Brook TR	Reading	In Service	163.01	Significant
Pinney Hollow	Pinney Hollow Brook	Plymouth	Removed	156.09	N/A
Lower Moore Pond	Pinney Hollow Brook	Plymouth	In Service	156.03	Significant
Upper Moore Pond	Pinney Hollow Brook	Plymouth	In Service	156.04	Significant
Billings Pond	Barnard Brook	Woodstock	In Service	254.01	Low
The Pogue	Barnard Brook TR	Woodstock	In Service	254.08	Low
Lakota Lake	Richmond Brook	Barnard	In Service	11.05	Significant
Martin	Cloudland Brook TR	Pomfret	In Service	157.02	Significant
Breakneck Hill	----	Pomfret	----	157.06	N/A
Gray Camp Pond	Barnard Brook TR	Barnard	In Service	11.01	Low
Line Pond	Barnard Brook TR	Barnard	Deleted[1]	11.06	N/A
Kellogg Pond	Barnard Brook TR	Barnard	In Service	11.03	Significant
Sonnenburg Ski Area	Barnard Brook TR	Barnard	In Service	11.04	Low
Noble Pond	Gulf Stream TR	Bridgewater	In Service	28.03	Significant

Dams of the Connecticut River watershed					
Dam Name	Stream	Town	Status	State ID	Hazard Class
Hurricane Lower Reservoir	Kilburn Brook	Hartford	Breached (Partial)	94.04	Significant
Wright Reservoir	Connecticut River-TR	Hartford	Drained	94.05	Significant
Hurricane Upper Reservoir	Kilburn Brook-TR	Hartford	Breached (Partial)	94.03	Low
Simonds Reservoir	Kilburn Brook-TR	Hartford	In Service	94.06	Low
Stokien	Weed Brook	Hartland	In Service	95.02	Low
Martinsville	Lulls Brook	Hartland	In Service	95.03	Low
Bronson	Lulls Brook-TR	West Windsor	In Service	239.04	Significant
Rawson	Lulls Brook-TR	West Windsor	In Service	239.02	Significant
Prison Pond	Hubbard Brook-TR	Windsor	In Service	248.07	Significant
Lake Runnemede Dike	Connecticut River-TR	Windsor	In Service	248.08	Low
Lake Runnemede	Connecticut River-TR	Windsor	In Service	248.01	Significant
Windsor (Lower)	Mill Brook	Windsor	Breached	248.03	N/A
Windsor Upper	Mill Brook	Windsor	In Service	248.02	High
Mount Ascutney Effluent Pond	Mill Brook-OS	West Windsor	In Service	239.07	Low
Mount Ascutney Snow Pond	Mill Brook-OS	West Windsor	In Service	239.08	Low
Howland	Mill Brook-TR	West Windsor	In Service	239.01	Significant
Hammondsville Mine	Reading Hill Brook - OS	Reading	In Service	163.08	Low
Windsor Minerals Pond #9	Mill Brook-TR	West Windsor	In Service	239.05	Low
Windsor Minerals Pond #10	Mill Brook-TR	West Windsor	In Service	239.06	Low
Cooks Pond	Blood Brook	Weathersfield	In Service	229.08	Low
Firehouse	Mill Brook	West Windsor	In Service	Unmapped	Unknown
Harrington	Mill Brook	West Windsor	Breached	Unmapped	Unknown

APPENDIX F. – USACE / VT ANR / USFWS Agreement & ANR Factsheet

U.S Army Corps of Engineers & Vermont Agency of Natural Resources
Coordination Plan for
Operating Federal Flood Control Dams in Vermont

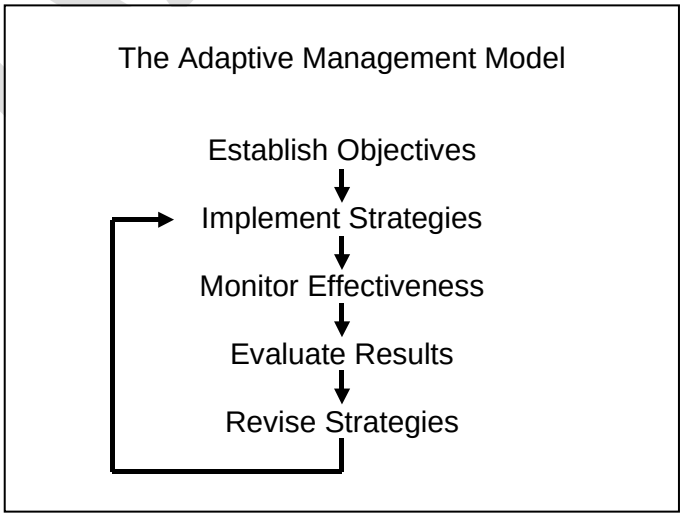
Background

In recent years, a number of concerns have been raised pertaining to the operation and maintenance of Federal flood control dams in Vermont and across the New England District. To address these concerns, the Vermont Agency of Natural Resources (VANR), U.S. Fish and Wildlife Service (USFWS), and U.S. Army Corps of Engineers (Corps) have engaged in collaborative discussions since 1999 to identify ways to improve operations at the five Corps' flood control projects in Vermont: Union Village, North Hartland, North Springfield, Ball Mountain and Townshend. As a result of these discussions, operational improvements have been enacted, including implementation of conservation flows and ramping standards.

To build on the work performed to date, the three agencies are implementing a three-year adaptive management process (AMP) to use as a framework for identifying and resolving issues of concern. The goal of the process is to evaluate current operational and maintenance practices and identify ways to maintain and restore the integrity of the downstream and upstream aquatic and terrestrial ecosystems while maintaining the projects' primary purpose of flood control and recognizing other recreation and natural resource management objectives.

The Adaptive Management Process

A basic tenet of adaptive management involves continued monitoring and evaluation leading to revised strategies that will achieve the desired results (see figure). This approach allows the participants to address problems and areas of uncertainty over time. In this case, issues related to the operation, maintenance and modification of the flood control projects will be addressed.



Each of the three participating agencies will designate representatives to a working group that will implement this plan. Other participants will be called in as needed to provide their expertise on specific issues.

A key part of the process is the annual interagency coordination meeting, to be held in January of each year. This meeting will provide the agencies with an opportunity to review the previous years' operations, revise operational and monitoring procedures, and raise new issues. Other meetings or site visits will be held as needed.

A number of issues identified and discussed in this plan require resolution or effectiveness monitoring. Adaptive management relies upon the collection of data that can be used to make appropriate adjustments. Assessment

plans (for monitoring/assessment/evaluation) will be developed for each pending issue so that participating agencies have the information needed to move forward at each annual meeting.

Responsibility for administering the adaptive management process will rotate among the three agencies on an annual basis. The U.S. Fish and Wildlife Service will take the lead in the first year, followed by the Vermont Agency of Natural Resources, and then the U.S. Army Corps of Engineers. Administrative duties include organizing meetings (scheduling, preparing agendas, preparing meeting notes) and site visits. Each agency will be responsible for suggesting meeting agenda topics and preparing any necessary background material. Any modifications or operational changes agreed to by the parties will be incorporated into the operating and maintenance policies and practices of each project.

The Adaptive Management Plan

Regulation of flood control dams involves both flood control and non-flood control operations. In general, flood control operations involve the coordinated regulation of dams located on tributaries to reduce flood damages downstream of the dam and to reduce flood damages collectively on the Connecticut River. Flood control operations are authorized by Congress and implemented by the reservoir regulation manual for projects in the Upper Connecticut River Basin.

Non-flood control operations describe the scheduled or recurring regulation of the dams for other purposes. Flood control projects in Vermont are authorized to perform natural resources management activities and provide public recreational opportunities. A hydropower facility was added to North Hartland Dam at a later date.

Objectives:

- Maintain the dams' flood control function while mitigating the ecological impacts of flood control operations.
- During non-flood control periods, maintain downstream flows as close to instantaneous run-of-river as feasible, with outflow equal to inflow.

The following sections discuss a number of issues related to dam operation and identify those that will be addressed in the adaptive management process.

Flood Control Operations:

The Corps has maintained that it is necessary to maintain maximum operational flexibility during flood control periods. However, VANR and USFWS have expressed concerns about the ecological impacts of flood control operations. While the Corps has implemented ramping and conservation flow standards, the VANR and USFWS do not consider those standards protective of downstream resources and have advocated that more information be provided on how more protective standards would affect flood control capabilities.

Both ANR and USFWS have expressed an interest in learning when the projects are in flood control operations. The Corps will provide background information on how these decisions are made. Rather than try to define theoretically what may constitute flood operations at the dams, the Corps prefers to find a reliable way to contact and notify ANR and USFWS and incorporate this into the Communication Procedures.

Conservation flow, ramping, and reservoir release/refill standards for flood control operations will be addressed during the adaptive management period.

Routine Operations:

The Corps, ANR, and USFWS have agreed to the concept of routinely operating the dams in instantaneous run-of-river mode (outflow equal to inflow) outside of flood control periods. Differences remain on how closely releases from the dams should equal inflow. These differences are most evident at North Hartland and Ball Mountain, where pools are maintained year-round and outflow is controlled by the gate openings. It is also an issue, to a lesser extent, at Union Village, which has a pool in the winter only. VANR has identified problematic flow fluctuations and instances where flows fall below ABF during routine operations at these projects.

Over a 3-year period, the Corps will increase flow monitoring and gate adjustment frequency to twice a day during the work week and on the weekends if necessary, at Union Village (winter only), North Hartland, and Ball Mountain. Further, the parties will review the procedures used to monitor and adjust gate settings and develop procedures to improve routine daily flow management. The objective of this exercise is to develop procedures that will maintain outflow equal to inflow to the greatest extent feasible.

Non-Flood Control Operations:

While the general goal is run-of-river operation, the parties have identified circumstances, outside of flood control operations, when flow or reservoir stage manipulation is necessary or appropriate. Those circumstances are listed below and described in more detail in subsequent sections.

1. Whitewater boating releases
2. Periodic inspections
3. Beach maintenance
4. Major maintenance and rehabilitation
5. Emergency operations

As noted in the detailed descriptions, there is not consensus among the parties regarding when flow or stage manipulation is necessary.

During such periods, the Corps will employ conservation flow, ramping, and reservoir refill standards that serve to protect the ecological integrity of the downstream reach.

With respect to conservation flows, the Corps has implemented the USFWS Aquatic Base Flow (ABF) standard for non-flood control operations at all projects. The ABF standard is based on the drainage area at the dam and is expressed in cfs/mile or csm. The rates vary seasonally:

October – March: 1.0 csm (or inflow)
April – May: 4.0 csm (or inflow)
June – September: 0.5 csm (or inflow)

The Corps has agreed to maintain the seasonal ABF flow at all times when flows are being manipulated (i.e., non run-of-river) outside of flood control operations, provided inflows are equal or greater than ABF.

Similarly, ramping rates have been adopted at all projects for use during all operations (including routine) outside of flood control periods. The ramping rates are 0.5 csm/hr for flows up to 4.0 csm, and 1.0 csm/hr for flows greater than 4.0 csm.

Reservoir water level management is the final water management issue. Reservoir refill standards have been implemented by the Corps. When refilling the reservoir or raising the reservoir to an increased target level during non-flood periods, the seasonal ABF will be maintained at all times except when flows are below ABF. If inflows are less than ABF, then a 70/30 rule will be implemented whereby the dam will pass at least 70 percent of inflow while storing no more than 30 percent.

The Agency of Natural Resources contends that the 70/30 rule does not provide adequate protection for downstream resources, and has proposed a 90/10 rule, with 90 percent of inflow being released downstream. Resolution of this issue will be a priority of the adaptive management process.

During the AMP, a clear statement of seasonal reservoir target elevations will be developed. Other issues related to reservoir water level management will be identified by the parties within the first year of the adaptive management process and addressed.

Whitewater boating releases

The Corps has provided releases to accommodate scheduled recreational boating events at many of its dams for over forty years. At present there are two whitewater release events scheduled at Ball Mountain Dam and Townshend Lake. These releases, which are timed to coincide with planned seasonal regulations of the conservation pool, are scheduled for the last weekend in April and again in late September. In recent years, the resource agencies have raised concerns about the ecological impacts of these releases. In response, beginning in 2003, the Corps adopted the minimum conservation flows and ramping rates recommended by the U.S. Fish and Wildlife Service for each project.

For the spring release on the West River, the Corps will follow the ANR/USFWS ramping and refill rates agreed to by the parties. In addition, an overnight flow of 4.0 csm will be maintained. The target pool elevation at the start of this release will be approximately 75 feet with a target pool elevation of 25 feet at the end. Releases beyond the last weekend in April will not be considered due to the need to pass salmon smolts downstream in the spring.

For the fall release on the West River, the Corps will follow the ANR/USFWS ramping and refill rates agreed to by the parties. Beginning in 2003, the Corps has released water to support a one-day event. A full two-day event may be possible under conditions when where there is sufficient inflow to support a second day while employing ramping and 4.0 csm flows overnight. The target pool elevation at the start of this release will be 65 feet with a target pool elevation of 35 feet at the end.

Periodic inspections

To assure the integrity and ability of a flood control dam to perform its authorized purposes, inspection of the entire dam and related structures is performed every five years. Periodic inspection is required for the continued operation of the dam. In the future, the Corps will perform conduit and outlet works and gate inspections without restricting outflows from the control structures if and when possible. During these inspections, the flood control gates must be operated for structural, mechanical and electrical performance.

Minor fluctuations to the outflow could be encountered during periodic inspection; however, testing of flood control gates will generally not occur during low-flow periods.

The preferred time to conduct conduit inspections will be during low-flow periods when this can be completed without interrupting river flows. The Corps will attempt to perform conduit inspections both prior to and during the scheduled fiscal year of the periodic inspection. If this is not feasible, some reduction of river flows may still be required in order to conduct a satisfactory inspection. Periodic inspections of dams in Vermont are scheduled as follows:

2002 – North Springfield Lake, Townshend Lake
2003 – None
2004 – Ball Mountain Dam, North Hartland Lake, Union Village Dam
2005 – None
2006 – None
2007 – North Springfield Lake, Townshend Lake

The following monitoring and operational procedures will be performed to minimize impacts during the inspection event:

If the outlet works and conduit can be safely inspected without disruption of flow during low-flow periods, the periodic inspection, and/or the inspection of the conduit/flood control gates, will be conducted at that time. To increase the probability of being able to perform conduit inspections during low-flow periods, the Corps will conduct inspections, if possible, whenever these naturally occur.

If reductions of flow are necessary to perform conduit inspections, outflow will be reduced only to the extent needed to safely inspect the conduit (historically < 1 hour). Under extenuating circumstances, the inspections may take longer to complete. Prior to and during each conduit/flood control gate inspection, the Corps will have biologists evaluate the impact of any planned gate operation on the upstream and downstream communities and habitat. During any shutdown, biologists will be stationed downstream of the conduit to monitor river conditions and rescue stranded fauna. These monitoring activities and protocols will be coordinated with the VANR and USFWS. In 2002, monitoring protocols for performing conduit inspections were developed and implemented at North Springfield Lake. Further refinement of periodic inspection and monitoring procedures are a high-priority for the AMP.

Beach Maintenance

The Corps maintains public swimming beaches in Vermont at North Hartland Lake, Townshend Lake and at Stoughton Pond at North Springfield Lake. These beaches are maintained annually to inspect the public swimming area and to remove debris and sedimentation that collects on the beach over the winter and when flood storage events inundate the beach and swimming area. The Corps will attempt to perform maintenance of the public swimming beaches without drawing down the conservation pool. As part of this AMP, the parties will develop a process to determine if a satisfactory and safe facility can be maintained without water level manipulation.

The Corps has prepared a draft beach maintenance SOP that addresses issues surrounding the timing and mechanics of performing beach maintenance to minimize impacts to both downstream and reservoir aquatic habitats and species. VANR and USFWS will review the SOP and provide suggestions and alternatives for

maintenance activities. Upon review and finalization, the beach maintenance SOP will be submitted to the agency representatives for their review and concurrence.

Major Maintenance and Rehabilitation:

Major maintenance and rehabilitation of the dams and appurtenant structures are necessary for their continued operation. These are large-scale projects, so they will be planned and coordinated separately from other routine or recurring activities. Close coordination with VANR and USFWS will begin early in the planning process and continue through project completion.

Emergency Operations:

Occasionally, the Corps will need to operate the dams in response to unplanned emergencies. These emergencies include acts of God, casualties, disasters, national defense or homeland security emergencies. At these times it may become necessary to take immediate steps to contain, limit, or alleviate an emergency in order to protect human health, safety, and welfare prior to initiating any form of coordination or consultation with other agencies or individuals. In these instances, the Corps will contact VANR and USFWS, among others, as soon as practicable, if emergency modification or interruption of flows has occurred.

Fish Migration and Passage:

Ball Mountain Dam and Townshend Lake have been modified to allow for passage of Atlantic salmon. The facilities at Ball Mountain Dam consist of one automated gate and at Townshend Dam a modified weir to allow for outmigration of salmon smolts. A trap-and-truck facility was constructed at Townshend Lake in 1993 to allow migrating adults to be trapped from the West River below Townshend Dam and transported above Townshend Lake and Ball Mountain Dam to locations identified by Vermont Fish and Wildlife. In 2002, the trap-and-truck facility at Townshend Lake was upgraded to a variable array electric barrier that was designed, constructed and operated in a manner that has significantly reduced gate operations and minimizes impacts to the downstream aquatic habitat. North Springfield Lake also has a modified outlet pool to protect salmon smolts.

Project Modifications:

The Corps recognizes a need to study the performance of the outlet works at Union Village Dam, North Hartland Lake and Ball Mountain Dam. At these projects, the Corps ability to maintain permanent or seasonal conservation pools, as well as maintaining run-of-river conditions, without a weir or static flow control structure is difficult. Another related issue is the repair or modification of the outlet gates at Townshend Lake.

In 1995, the Corps prepared a sedimentation study for Ball Mountain Dam that identifies and evaluates structural alternatives to the project. The study addressed the prevention of unplanned silt discharges into the West River resulting from faulty gate operations or failure of the automated gate operators.

The Corps recognizes the need for further study to identify and implement structural changes to the Vermont flood control dams to alleviate flow regulation problems and enhance the aquatic habitat. Any future study to modify these dams would need to be conducted under existing authorities. If current authorities are not workable, the agency representatives will pursue other funding or authorities. As part of the adaptive management process, the Corps will investigate water temperature problems at North Springfield and Townshend Lakes to address potential warm water invasion created by shallow conservation pools and top-

spilling weirs. The Corps Water Quality Team is available to prepare study parameters and provide an alternative analysis of possible solutions.

The agencies have prioritized their respective needs. The agencies will jointly prioritize the respective priorities and propose a plan to implement studies or improvements.

- Vermont Agency of Natural Resources priorities:
  - Flow regulation improvement at Ball Mountain
  - Flow regulation improvement at North Hartland
  - Winter flow regulation improvement at Union Village
  - Downstream temperature impacts at Townshend
  - Downstream temperature impacts at North Springfield

- U. S. Fish and Wildlife Service priorities:
  - Feasibility studies of weirs at all gate-operated projects
  - Feasibility studies of converting projects with conservation pools to dry bed systems

- Corps of Engineers priorities:
  - Feasibility of weirs at Ball Mountain and N. Hartland Lake
  - Instream flow study on West River downstream of Ball Mountain Dam
  - Instream flow study on Black River downstream of N. Springfield Dam
  - Instream flow study on Ompompanoosuc River downstream of Union Village Dam

Coordination:

The following agency representatives should continue to serve in the capacity of moderators for meetings and dispute resolution. This Adaptive Management Plan and attachments will prevail unless amended and agreed to by all agencies. All parties involved in the preparation, implementation and evaluation of this plan agree to present their recommendations to these representatives for resolution or implementation prior to elevating their concerns to other persons, offices or agencies.

_____ _____
Supervisor, New England Field Office Date
U.S. Fish and Wildlife Service

_____ _____
Acting Director, Water Quality Division Date
Department of Environmental Conservation
Vermont Agency of Natural Resources

_____ _____
Chief, Construction/Operations Division Date
New England District
U.S. Army Corps of Engineers

APPENDIX G. – Draft Plan Public Comment Responsiveness Summary

Basin 10 Water Quality Management Plan
Public Comments Responsiveness Summary

APPENDIX H. – Potential funding sources

Lists of potential funding source are maintained by numerous state agencies and are continuously being updated. Many of these can be found at:

Agency of Natural Resources

- Department of Environmental Conservation
  - http://dec.vermont.gov/watershed/funding
- Vermont Fish and Wildlife Department
  - http://www.vtfishandwildlife.com/cms/one.aspx?portalid=73163&pageid=85025
- Department of Forests, Parks and Recreation
  - http://fpr.vermont.gov/about_us/grants

Agency of Agriculture Food & Markets Grants & Programs

http://agriculture.vermont.gov/producer_partner_resources/funding_opportunities/vaafm_funding

Farmer Assistance

- Ag-Clean Water Initiative Program (Ag-CWIP)
- Best Management Practices (BMPS)
- Conservation Reserve Enhancement Program (CREP)/Grassed Waterways
- Farm Agronomic Practices (FAPs)
- Nutrient Management Planning & Land Treatment Planning
- Capital Equipment Assistance Program (CEAP)

Agency of Commerce and Community Development

http://accd.vermont.gov/search/node/grants

Agency of Transportation

- Better Roads
- Municipal Highway and Stormwater Mitigation Program
- Transportation Alternatives

Federal Emergency Management Administration (FEMA)

- https://www.fema.gov/grants

APPENDIX I. – Regulatory and Non-Regulatory Programs Related To Protecting and Restoring Waters

The Vermont Surface Water Management Strategy maintains a roster of regulatory and non-regulatory technical assistance programs.

Regulatory programs may be accessed at:
http://dec.vermont.gov/sites/dec/files/documents/wsmd_swms_Appendix_A_Vermont_Regulations_Pertaining_to_Water_Quality.pdf

Non-regulatory programs may be accessed at:
http://dec.vermont.gov/sites/dec/files/documents/wsmd_swms_Appendix_D_Toolbox.pdf

Acronyms

ACEP – ALE – Agricultural Conservation Easement Program/Ag land easement
ACEP – WRE – Wetlands Restoration Easements
BFE – Base flood elevation
BMP – Best management practices
EQIP – Environmental Quality Incentives Program - Field practices, barnyard improvement, waste management
FA – financial assistance – payments directly to farmers for projects
FAP – Farm Agronomic Practices
NMP – Nutrient Management Plans
NRCS – Natural Resources Conservation Service
RCPP – Regional Conservation Partnership Program
TA – technical assistance – people to help design, implement projects for farmers
VACD – VT Association of Conservation District

VERMONT

AGENCY OF NATURAL RESOURCES

Agency of Natural Resources
Department of Environmental Conservation
Water Quality Division
Waterbury, VT 05671-0408